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ORIGINAL ARTICLES

UDIES ON THE METHODS OF ESTIMATING TOTAL BACTERIAL COUNTS IN THE SOIL

W. V. B. Sundara Rao, S. V. Desai and M. K. Reddy, Imperial Agricultural Research Institute, New Delhi

(Received for publication on 27 June 1944)

om a study of the micro-organisms in pure cures, the morphology and general physiology he organisms and an indication of the limits of ir activity can be obtained. But to obtain ormation regarding the way in which the ro-organisms of the soil live and work under ural conditions, we have to take recourse to dies in soil. Of the several methods of studies oil, the statistical method in which the number bacteria in the soil are estimated and are died in relation to other quantities (factors) ler strict statistical control deserves a trial. this, among other data, an exact number of total number of micro-organisms in the soil equired.

Plate method and direct count method are usual methods employed for estimating total terial numbers. Earlier studies with the plate nt method of Thornton [1922] showed that h 10 plates the per cent standard error between tes was below 8 in eight out of ten cases while h 3 plates the value was over 11 in nine out of teen cases (Table I). Thus a minimum of plates appears to be necessary to obtain an r within 10 per cent. However, the bacterial nbers obtained by the plate method are not ly to represent the total bacterial content of soil in view of the following generally re-nized limitations:

(1) The strict anaerobic micro-organisms are luded as well as the important groups of ifying, non-symbiotic nitrogen fixing, sul-ur oxidizing bacteria, to some extent denitri-ng, symbiotic nitrogen fixing, pectin and ulose decomposing bacteria. (2) High dilu-s are necessarily used so that if groups of ro-organisms are determined on the plate, those anisms occurring in small numbers will give ther inaccurate count.

After a trial of over 12 years Thornton and y [1934] expressed their opinion that it was uncertain whether those organisms that on the medium employed are of main im-ance in carrying out biochemical processes in soil and that it was necessary to develop the direct count method by which alone it would be possible to obtain an estimate of the total bacteria present in the soil.

Table I

Plate method

(Samples from different plots)

Sample	Mean Count.	S.E. between Plates	Per cent S.E.	C.V.
Using 10 plates.				
		Delhi Soil.		
1	80	±4·1	±5·13	16·22
2	70	±6·96	±9·5	30·11
3	82·2	±5·9	±7·2	22·77
4	80·3	±3·6	±4·41	13·95
5	132	±10·9	±8·3	26·25
6	115	±6·0	±5·2	16·44
7	85	±6·6	±7·1	22·44
8	98	±9·7	±10·9	34·47
		Pusa Soil.		
1	66	±3·6	±5·5	17·39
2	64	±0·66	±1·0	3·16
Using 3 plates.				
		Guntur Soil.		
1	87·6	2·33	2·7	4·18
2	93·6	4·3	4·6	7·95
3	60·0	2·6	4·3	7·45
		Pusa Soil (root zone)		
1	35·3	5·8	16·0	27·71
2	29·3	5·0	17·1	29·62
3	34·7	5·8	16·7	28·93
4	45·3	6·7	15·2	26·97
5	35·3	6·9	19·6	33·95
		Pusa Soil (away from root zone)		
1	24·7	4·8	19·4	33·61
2	20·3	4·3	21·1	36·54
3	23·7	0·67	2·8	4·85
4	28·0	6·4	22·2	..
5	11·7	2·7	11·3	38·45

A suitable staining technique for enabling bacteria to be distinguished in soil films was developed by Conn [1918] and further modified by Winogradsky [1925]. Two very serious difficulties had, however, prevented this technique from being developed into an exact quantitative method. These were (*a*) the difficulty of estimating with any accuracy the minute mass of the soil examined in a thin film, and (*b*) the fact that the bacteria were not distributed at random over the film from which the microscope fields had to be taken as samples. These difficulties were eventually overcome by means of a ratio method, developed by Thornton and Gray [1934], the principle of which was as follows :

'A suspension of indigotin particles averaging one micron in diameter is made up and the number of particles per c.c. is determined by means of hæmocytometer. A known mass of soil is shaken up in a known volume of this counted suspension. Films of the resulting mixture are prepared and stained with an acid dye like Erythrosine (sodium or potassium salt of tetraiodo fluorescein) which stains only organisms but not organic matter (since most of soil organic matter is in humic acid condition). The bacteria and indigotin particles are counted in a suitable number of random microscope fields and the ratio of bacteria to indigotin is determined. Since the absolute number of indigo particles added per gram of soil is known, the number of bacterial cells is calculated from the ratio according to the formula $O = 5Y\frac{B}{I}$ —(1)

where Y = the number of indigo particles per c.c. of the suspension, 5 c.c. of which were added per gram of soil, and B and I the total number of organisms and indigotin particles respectively, counted in the films.

The calculation here is independent of the quantity of the soil in the film. The ratio of the bacteria to indigotin show a random distribution over the films and the actual number of bacteria per gram of soil is calculated from this ratio.'

Thus the two serious difficulties that prevented the direct count method from becoming an exact quantitative method were overcome. An attempt was made to test this method in these laboratories

Experimental

The soil samples selected were (1) Pusa soil (silty loam), and (2) Guntur soil (heavy black cotton soil) differing widely in mechanical composition as below :

Soil	Sand	Clay
Pusa	70%	5·6%
Guntur	14·6%	64%

The soil sample in each case was sieved through 1 mm. sieve and was spread evenly on a large sheet of paper and divided into four different portions and one composite portion was made therefrom. Counts were taken from all the five portions. The procedure followed for the estimation of the bacterial numbers by the direct count method was the Thornton's method [1934], with some alterations in some details of technique which were found necessary.

Alterations made in the method. While Thornton [1934] employed an indigotin suspension containing 500 million particles per c.c., the indigotin suspension employed during the present investigation was made to contain only 25 to 35 millions. Indian tropical soils contain usually less number of organisms than the soils of the temperate regions. If the value $\frac{B}{I}\frac{\text{(Bacteria)}}{\text{(Indigotin)}}$ is made large by reducing the number of indigotin particles, then slight errors in counting bacteria will not alter the ratio much and as such wide variations are not likely to be introduced, as a result of this error, in the final calculated number of organisms in the different aliquot (of equal quantities) of the same soil sample.

Further, an alteration had to be made in the method of counting the indigotin particles and bacteria on the soil film. Thornton and Gray [1934] suggested that it would be best to insert in the eye piece a glass disc ruled with a square having 2 mm. side and to take only the area covered by the square as the field. But in our experiments the square was not inserted. The counts were taken over the entire field, since the bacteria and indigotin particles in an area of 2 mm. square were too few. Better agreement in the value $\frac{B}{I}$ could be had since the field area was greater.

sting the accuracy of the method

(1) *Agreement between replicate microscope fields d drops.* It was mentioned in the introduc-on that a serious source of error in many direct ethods of counting soil organisms had been e uneven distribution of stained bacteria over e films. In the method developed by Thorn-n and Gray [1934] it was claimed that the tio of number of organisms to numbers of digotin particles would be more uniformly stributed than the organisms taken by emselves. This was now tested by calculating e x^2 indices of dispersion between replicate croscope fields. These values were calculated r five series of counts from three soils examined. ie results are shown in Table II where column gives the number of degrees of freedom 'n' r each count, columns B and C show x^2 dices and the corresponding value of P for e counts of micro-organisms taken by emselves. Here the micro-organisms were unevenly distributed over the films, the values of x^2 being excessive. Columns D and E show x^2 indices with their values of P for the ratios derived from the same replicate microscope fields. These values denote that there was randomized distribution of the ratios. Thus while the micro-organisms were unevenly distributed over the films, the ratios (of number of micro-organisms to the number of indigotin particles from the same microscope field) did not show excessive variability over these films. This was probably due to the surface tension forces acting similarly upon the micro-organisms and indigotin particles which were nearly of the same size.

When a large mass of data is to be examined it will be convenient to take drop instead of field as unit. A comparison of replicate drops also shows any variability that may be introduced during the making of the drops. Table III shows the x^2 values for the drop ratios of 5 portions of each of the soils examined. In each portion of the soil examined it will be observed from the corresponding x^2 values, that the ratios were distributed at random.

TABLE II

Indices of dispersion for ratios of organisms to indigo particles and for organisms alone in replicate microscopic fields

Soil		A	B	C	D	E
		N	x^2 of organisms alone	P	x^2 of ratios	P
s away from roots	1	63	450·21	<0·001	17·89	Nearly 1
	2	47	232·0	<0·001	5·96	,,
	3	55	792·4	<0·001	9·53	,,
	4	63	267·73	<0·001	3·28	,,
	5	63	132·29	<0·001	6·38	,,
sa root zone .	1	63	445·84	<0·001	4·68	,,
	2	55	253·72	<0·001	4·41	,,
	3	63	432·11	<0·001	8·5	,,
	4	63	466·8	<0·001	7·18	,,
	5	55	516·67	<0·001	11·36	,,
ntur . .	1	63	133·9	<0·001	4·99	,,
	2	63	275·51	<0·001	5·09	,,
	3	63	221·51	<0·001	5·29	,,
	4	63	242·13	<0·001	4·26	,,
	5	63	332·27	<0·001	10·16	,,

TABLE III

Counts of micro-organisms

Sample	Organisms	Indigo	Ratios	x^2 between drop ratios $N = 15$	Micro-organisms per gram of dry soil, in millions
1. From five portions of a sample of soil from Pusa (away from roots)					
1	1125	557	2·020	1·752	97·65
2	2065	1033	1·990	0·811	96·80
3	1532	757	2·024	1·521	97·85
4	1471	722	2·034	2·090	98·50
5	1941	951	2·040	1·781	98·50
					± 0·315
					± 0·322%
2. From five portions of a sample of soil from Pusa (root zone)					
1	3214	797	4·033	1·008	195·0
2	2731	677	4·034	0·496	195·0
3	3392	844	4·019	0·362	194·3
4	2987	734	4·070	0·542	196·8
5	2400	596	4·028	1·1565	194·7
					±0·43
					±0·22%
3. From five portions of a sample of soil from Guntur					
1	2987	476	6·275	0·811	1058·00
2	3606	581	6·206	0·476	1046·40
3	2834	456	6·215	1·567	1047·85
4	3177	496	6·405	1·205	1080·00
5	3723	590	6·310	1·238	1055·00
					±6·02
					±0·413%

(2) *Consistency of results.* Two workers made counts from different microscope fields from every drop on the slides prepared from each of the five portions of the Pusa soil sample. In the absence of

a personal error, their counts should agree as random samples. Table IV shows the number of micro-organisms and of indigotin particles counted and the ratios obtained by each worker from each of the five portions. The sum of x^2 indices of dispersion between the two workers' counts from individual drops of each portion were entered in column 11 of Table V. The two series of counts agreed within random sampling, personal error being very little. The calculated numbers agreed closely

TABLE IV

Counts of micro-organisms by two workers from five portions of a sample of soil from Pusa Plot No. 3-A

(October sample away from roots)

DIRECT COUNT METHOD

No.	Slide 1	Slide 2	Slide 3	Slide 4	x^2 for slide ratios	Total	Organisms in millions per gm. of soil	Slide 1	Slide 2	Slide 3	Slide 4	x^2 for slide ratios	Total	Organisms in millions per gm. of soil
	$\frac{b}{i}$	$\frac{b}{i}$	$\frac{b}{i}$	$\frac{b}{i}$		$\frac{B}{I}$		$\frac{b}{i}$	$\frac{b}{i}$	$\frac{b}{i}$	$\frac{b}{i}$		$\frac{B}{I}$	
1	528/236	194/194	189/91	214/106	0·1305	1125/557	97·65	811/396	409/202	644/323	395/101	0·1369	2259/1112	97·78
2	95/46	426/217	762/369	785/401	0·4081	2068/1033	96·80	..	271/131	518/256	471/245	0·3445	1260/632	96·35
3	891/303	484/234	150/71	307/149	0·4690	1532/757	97·75	432/210	472/202	556/279	562/281	2·5630	2022/981	96·66
4	360/181	399/195	380/187	332/159	0·1265	1471/722	98·50	675/327	874/427	522/276	520/246	0·3027	2661/1276	100·83
5	588/280	451/225	444/220	458/226	0·2984	1941/951	98·50	850/412	655/314	538/256	478/228	0·0463	2521/1210	100·73
						S.E. = ± 0·315 (± 0·322%)							S.E. = ± 0·307 (± 0·312 %)	

Formula for $x^2 = \frac{1}{BI}\Sigma\left\{\frac{(bI-Bi)^2}{b+i}\right\}$

Where b and i are the bacteria and indigo counted in each slide and B, I are the total bacteria and indigotin particles counted

TABLE V

Counts of micro-organisms by two workers from five portions of a sample of soil from Pusa Plot No. 3-A

Sample	Counts by W. B. S. Rao: Organisms	Indigo	Ratios	x^2 between slide ratios	Counts by M. K. Reddy: Organisms	Indigo	Ratios	x^2 between slide ratios	n	x^2 between workers counting	Mean ratio	Millions per gm. of air dry soil
1	2	3	4	5	6	7	8	9	10	11	12	13
A	1125	551	2·0197	0·1305	2259	1112	2·0224	0·137	15	1·865	2·0211	97·719
B	2068	1033	2·0017	0·4801	1260	632	1·9940	0·345	10	0·969	1·9979	96·602
C	1532	757	2·0235	0·4690	2022	981	2·0610	2·560	13	1·866	2·0423	98·750
D	1471	722	2·0374	0·1265	2661	1276	2·0850	0·303	16	1·249	2·0612	99·655
E	1941	951	2·0211	0·2984	2521	1210	2·0830	0·046	16	1·583	2·0526	99·244
Total	8137	4020	..	1·5045	10723	5211	..	3·391	70	7·532	..	..
			$n = 15$				$n = 15$					
Mean											2·03522 S.E. = 0·2916 (0·2963%)	

Errors in sampling due to variation in grain ze. The soil selected was a sample from Guntur aving 8·4 per cent coarse sand. Sterilized sand as added to it to raise the percentage of coarse nd to 20, 30 and 40 and mixed thoroughly. hus four different types of soil differing in grain ze only, were obtained. Sand was sterilized by utoclaving for two hours at 15 lb. pressure.

1. Original soil 8·5 per cent coarse sand
2. Soil with 20 per cent coarse sand
3. Soil with 30 per cent coarse sand
4. Soil with 40 per cent coarse sand

In each of these soils the sample was spread n a sheet of paper and divided into four portions. ach portion was put into a separate bottle and abelled. The total bacterial counts were esti- nated in each portion by the direct microscope ount method. Table VI shows the results ob- ained.

TABLE VI

Total bacterial number variations with addition of sterile sand

DIRECT MICROSCOPE COUNT METHOD

	Bacterial number in millions per gm. of soil
I. Guntur Soil—original (coarse sand 8·5 per ent).—	
Portion 1	1,006·73
„ 2	1,036·8
„ 3	953·1
„ 4	977·1
Mean	993·43 (±1·78)
I. Guntur Soil (coarse sand 20 per cent)—	
Portion 1	855·55
„ 2	877·50
„ 3	827·65
„ 4	870·7
Mean	857·86 (±1·99)
II. Guntur Soil (coarse sand 30 per cent)—	
Portion 1	750·85
„ 2	702·36
„ 3	770·4
„ 4	727·7
Mean	737·8 (±2·16)
V. Guntur Soil (coarse sand 40 per cent)—	
Portion 1	662·97
„ 2	674·1
„ 3	665·6
„ 4	644·3
Mean	661·74 (±0·95)

From these results it appears that the percentage tandard error varied between 1 and 2. Further it can also be seen that the decrease in bacterial numbers per gram of soil corresponded to the increase in the amount of sterilized sand added.

Table VII shows the expected values and the values observed.

TABLE VII

Sample	Bacterial Nos. per gram of soil in millions		Difference percentage
	Expected	Obtained	
1 . .	993·43	...	...
2 . .	857·86	879·1	2·4
3 . .	737·80	779·8	5·3
4 . .	661·74	680·5	2·6

From these results it can be seen that the method is fairly accurate. The authors are greatly indebted to Rao Bahadur Dr B. Viswanath, C.I.E., F.I.C., D.Sc., Imperial Agricultural Chemist, for his advice during the course of this work.

SUMMARY

In the present investigation it was observed that in the plate count method a minimum of ten plates was necessary to obtain an error within 10 per cent. Since no single medium is suitable for the growth of all soil bacteria belonging to different physiological groups, the bacterial numbers obtained by plate method do not represent the total bacterial content in the soil. As such the direct microscope count method of Thornton and Gray [1934] was studied in detail as to the agreement between replicate microscope fields and between drops, consistency of results and the errors in sampling due to variation in grain size of the soil. This method with a few modifications in some details of the technique was found suitable to determine the total bacterial count in the soil within an error of ± 2 per cent.

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A STATISTICAL STUDY OF THE BOLL FORMATION IN COTTON

By D. N. Nanda and Mohammad Afzal, Cotton Research Laboratory, Lyallpur

(Received for publication on 23 October 1944)

(With one text-figure)

In the previous two papers of this series [Afzal and Iyer, 1934 and Nanda, Afzal and Panse, 1944] the growth in height and the flower production in four varieties of cotton, three American and one indigenous, were studied in detail. In the case of growth in height, the exponential equation $H=Ae^{bt}$ was found to fit the data and in the case of flowering a polynomial of the third degree of the Log $\frac{x}{a-x} = Y = A+BT+CT^2+DT^3$ was found suitable.

These studies have now been carried further and the boll formation in cotton has also been studied. The experimental data were collected from the Physiology Plot of the Cotton Research Laboratory, Lyallpur.

Two hundred average plants were selected at random in each of the four varieties, namely, 4F, 289F, 289F/43 and 39 Mollisoni just before boll opening started and the number of bolls picked per plant per day was recorded in each case. The bolling season was divided into intervals of 5 days and the progressive total of the number of bolls produced per plant during each interval was plotted. It was found that the summation curves of all varieties were of the characteristic S-shape.

The data were examined by fitting the logarithmic equation of the fifth degree in the time variable and it was found that the mean squares were in a few cases significant up to the fifth degree. The mean squares up to the third degree were practically always significant and it was, therefore, considered that the third degree equation may be considered to give the best fit. The equations for the average polynomials are given below :

4F . . $Y = -2{\cdot}5385 + 0{\cdot}3367t - 0{\cdot}0095t^2 + 0{\cdot}0002t^3$

289F . . $Y = -1{\cdot}5444 + 0{\cdot}2212t - 0{\cdot}0048t^2 + 0{\cdot}00007t^3$

289F/43 . $Y = -2{\cdot}2112 + 0{\cdot}4698t - 0{\cdot}0368t^2 + 0{\cdot}0012t^3$

39 Mollisoni $Y = -2{\cdot}6801 + 0{\cdot}6455t - 0{\cdot}0436t^2 + 0{\cdot}0015t^3$

As in the case of flowering, the average polynomial for each variety was calculated and the sum of squares contributed by the linear, the quadratic and the cubic components of the curves and the corresponding deviations from the average regressions were calculated. It was found that the average polynomial of the third degree was significant in all varieties except 289F as will be seen from Table I.

Table I

Sum of squares of the average regressions

Due to	4F			289F			289F/43			39 Mollisoni		
	D.F.	S.S.	M.S.	D.F.	S.S.	M.S.	D.F.	S.S.	M.S.	D.F.	S.S.	M.S.
Linear regression . .	1	176·6	176·6**	1	147·3	147·3**	1	88·23	88·23**	1	69·84	69·84**
Quadratic regression .	1	0·4004	0·4004**	1	0·1000	0·1000**	1	0·0412	0·0412	1	0·7043	0·7043**
Cubic regression . .	1	0·6994	0·6994**	1	0·0427	0·0427	1	0·5622	0·5622**	1	1·5113	1·5113**
Deviation from												
Linear regression . .	6	16·17	2·696**	6	37·49	6·248**	2	10·51	5·259**	4	22·38	5·595**
Quadratic regression .	6	2·926	0·4878**	6	2·268	0·3781**	2	0·4945	0·2472**	4	2·039	0·5097**
Cubic regression . .	6	0·4813	0·0802	6	2·210	0·3683**	2	0·1695	0·0847	4	0·7263	0·1815**
Residual . .	98	2·664	0·0271	77	1·274	0·0165	48	1·597	0·0332	60	0·5850	0·0097
Total . . .	119	200·0	..	98	190·7	..	57	101·6	..	75	97·79	

It will be seen from Fig. 1 that the deviations of the yearly curves from the average ones were usually significant, indicating thereby that as in the case of flower production, the rate of boll formation was also influenced by the seasonal factors to a great extent.

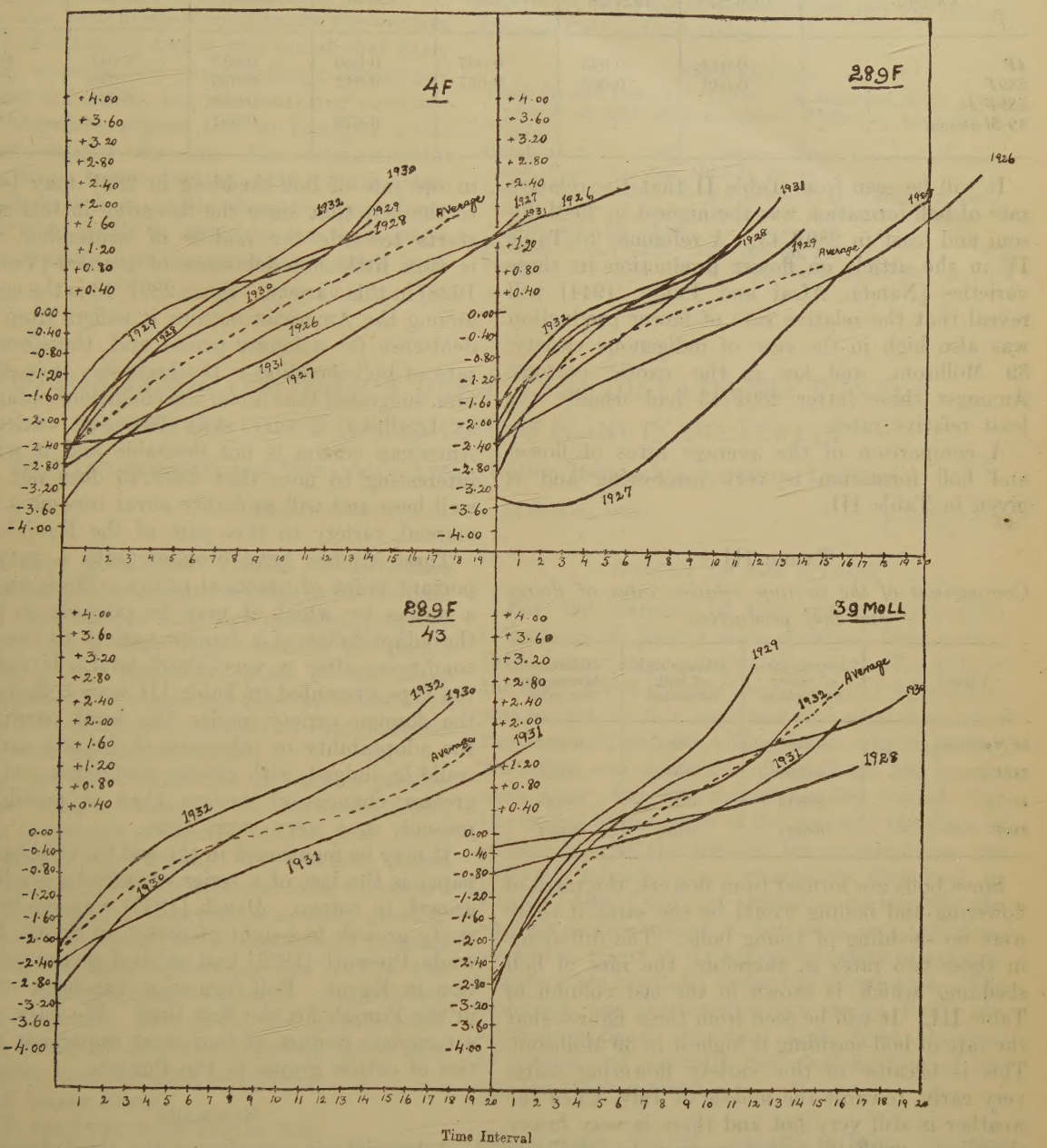

FIG. 1

Since the logarithmic equation fitted to the data was significant up to the third degree, the relative rate of boll formation cannot be considered to be constant. It was really a function of time.

The relative rates of boll formation for each variety are given in Table II.

TABLE II

Relative rates of boll formation

Variety	1926-27	1927-28	1928-29	1929-30	1930-31	1931-32	1932-33
4F	0·042	0·045	0·057	0·040	0·055	0·041	0·065
289F	0·042	0·065	0·057	0·042	0·070	0·070	0·050
289F/43	..	..	..	..	0·054	0·035	0·047
39 Mollisoni	..	..	..	0·079	0·051	..	0·061

It will be seen from Table II that the relative rate of boll formation was the highest in 39 Mollisoni and least in 289F/43. A reference to Table IV in the article on flower production in these varieties [Nanda, Afzal and Panse, 1944] will reveal that the relative rate of flower production was also high in the case of indigenous variety, 39 Mollisoni, and low in the exotic cottons. Amongst these latter 289F/43 had usually the least relative rates.

A comparison of the average rates of flower and boll formation is very interesting and is given in Table III.

TABLE III

Comparison of the average relative rates of flower and boll production

Variety	Average rate of flower production	Average rate of boll formation	Difference between the two rates
39 Mollisoni	0·0781	0·064	0·0191
289F/43	0·0601	0·045	0·0151
4F	0·0619	0·049	0·0129
289F	0·0631	0·057	0·0061

Since bolls are formed from flowers, the rates of flowering and bolling would be the same if there were no shedding of young bolls. The difference in these two rates is, therefore, the rate of boll shedding which is shown in the last column of Table III. It will be seen from these figures that the rate of boll-shedding is highest in 39 Mollisoni. This is because in this variety flowering starts very early, towards the middle of July, when the weather is still very hot and there is very heavy shedding. 289F/43 comes nearest to Mollisoni in this character and, therefore, the rate of boll-shedding is also high here. Next in order of lateness is 4F and the latest variety is 289F and the rates of boll-shedding are also of the same order in these two varieties. The very distinct fall in the rate of boll-shedding in 289F may be due to the fact that since the flowering in this cotton starts towards the middle of September, there is very little non-dehisence of anthers [Trought, 1928] in this variety. Since 289F/43 is the earliest among the American cottons it suffers from non-dehisence for a longer period and, therefore, the rate of boll-shedding is the highest. It is, therefore, suggested that under the conditions obtaining at Lyallpur, a very early flowering variety of American cotton is not desirable and it will be interesting to note that 289F/43 does not grow well here and will probably never become a commercial variety in this part of the Punjab.

These studies have brought forth a very important point of practical utility. Here we have a means by which it may be possible to judge the adaptability of a foreign variety to the local conditions after a very short trial. If data of the type presented in Table III were collected on the foreign variety under the local conditions, the adaptability or otherwise of the new varieties could be judged, with greater confidence and with greater chances of success than is possible at present, in a very short time.

It may be mentioned in the end that the present paper is the last of a series embodying studies in growth in cotton. Heath [1932] was the first to study growth in height of cotton in South Africa while Prescott [1922] had studied flower production in Egypt. Boll formation has been studied in the Punjab for the first time. We have, thus, a complete picture of four most important varieties of cotton grown in the Punjab.

SUMMARY

A logarithmic equation of the third degree has been fitted to the bolling data of cotton and it was found that although the mean squares were significant up to the fifth degree in a few cases, it was considered that the third degree would give a very good fit.

he relative rate of boll formation varied with time. This had to be the case, because, as viously reported, the rate of flower produc- n was also found to vary likewise.

t has also been possible to calculate the average e of boll-shedding and it was found that early turing varieties had comparatively higher rate boll-shedding than the late maturing varieties. was, therefore, argued that at Lyallpur a late turing variety fits into the environmental nplex much better than an early maturing one. s deduction from purely theoretical considera- n has been found to be a true one as no early turing variety can be successfully grown here.

ACKNOWLEDGEMENT

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COTTON JASSID (*EMPOASCA DEVASTANS* DIST.) IN THE PUNJAB

VI. SPECIES FOUND ON THE COTTON PLANT IN THE PUNJAB

By MANZOOR ABBAS and MOHAMMAD AFZAL, Cotton Research Laboratory, Lyallpur

(Received for publication on 28 October 1944)

VERY large number of species of *Empoasca* est different field and garden crops in the Punjab. ne of these species have not yet been properly ntified. As a very large number of insects onging to this genus are pests of one plant the other, it is suggested that an exhaustive ey will be of interest not only to entomologists to general agriculturists also.

n the previous literature on cotton jassids, y one species, namely, *E. devastans* Dist., been invariably mentioned as the pest of the ton plant in the Punjab. We, however, found t amongst the samples collected from the cotton ds at Lyallpur, a few specimens of other species, hitherto described, were almost always present. collection of these specimens was sent to the perial Entomologist, Imperial Agricultural search Institute, New Delhi, for identification as a result of this, the following three new cies have been brought to light :

(1) *E. minor* Pruthi,

(2) *E. kerri* var. *motti* Pruthi, and

(3) *E. punjabensis* Pruthi [Pruthi, 1940].

n order to find out the extent to which the new cies were present on cotton in different parts of province, a survey was carried out during the three years, the results of which are presented his paper.

SURVEY OF THE SPECIES

For the purpose of this survey, fortnightly collections of jassids were obtained from cotton fields from a large number of places. The help of the staff of the Punjab Department of Agriculture was sought for this work and the usual method of the hand-net and the killing bottle was employed. An effort was made to collect about 300 insects each time ; but the actual number varied with the extent of incidence of the pest and the place of collection. At the time of the examination, the external morphological characters described by Pruthi [1940] did not enable us to identify the various species except *E. devastans* and, therefore, we had to resort to the only alternative of examining the male genetalia under the microscope. The collection was examined in two stages, firstly the separation of *E. devastans* Dist. from the rest of species and secondly the identification of the various other species.

PERCENTAGE OF *E. DEVASTANS* DIST. IN THE DIFFERENT PARTS OF THE PROVINCE

The percentage of *E. devastans* in the fortnightly collections made from different important cotton growing tracts of the province is given in Table I.

TABLE I

Percentage of Empoasca devastans *Dist. in the jassid collection made from cotton during 1940-42*

Localities surveyed	JULY						AUGUST						SEPTEMBER						OCTOBER					
	Fortnight						Fortnight						Fortnight						Fortnight					
	I			II			I			II			I			II			I			II		
	1940	1941	1942	1940	1941	1942	1940	1941	1942	1940	1941	1942	1940	1941	1942	1940	1941	1942	1940	1941	1942	1940	1941	1942
Lyallpur	..	100·0	..	..	100·0	100·0	..	100·0	100·0	..	31·8	100·0	..	100·0	100·0	..	98·4	..	..	94·8	..	..	99·0	99·3
Khanewal	..	0·0	..	0·9	2·3	..	0·0	1·0	0·9	2·0	1·0	20·7	6·3	0·0	0·0	17·7	0·0	90·6	93·0	33·3	92·3	94·3	30·0	87·5
Multan	..	76·9	..	..	50·0	..	22·7	27·3	98·2	70·5	50·0	97·4	68·1	73·5	98·5	83·3	71·7	94·1	89·0	90·6	99·5	84·0	..	..
Montgomery	..	94·8	..	..	82·1	14·8	1·4	..	50·0	13·0	100·0	97·6	76·4	92·1	99·1	92·9	..	98·6	82·1	..	98·3	..	..	98·4
Bucheki]	..	..	..	..	..	..	..	..	..	..	..	..	..	100·0	100·0	..	100·0	100·0	..	100·0	100·0	..	100·0	100·0
Shahpur	..	100·0	..	..	100·0	100·0	..	100·0	100·0	..	100·0	96·3	..	94·4	100·0	..	..	..	..	100·0	99·0	..	..	98·0
Sargodha	..	96·3	..	1·6	50·8	96·3	68·0	98·7	..	27·8	93·3	94·1	98·9	100·0	92·4	92·0	98·4	90·9	87·0	98·3	..	..	87·3	..
Bhalwal	..	..	..	..	90·9	92·3	41·9	94·1	97·6	37·7	100·0	96·4	91·0	94·1	95·1	87·2	95·0	98·5	..	90·0	..	92·7	97·3	99·0
Chiniot	..	82·6	..	..	100·0	97·9	..	95·6	96·2	..	100·0	94·5	..	95·7	100·0	..	90·9	92·9	..	100·0	97·7	..	100·0	99·0
Hansi	..	94·1	..	..	100·0	..	80·1	100·0	92·0	92·7	94·7	99·3	97·3	100·0	98·6	96·9	98·3	98·6	92·7	92·3	99·6	..	75·7	99·2
Jhang	..	..	..	..	33·3	69·2	25·0	50·0	75·0	49·3	67·7	90·0	98·5	91·7	92·9	..	96·3	90·0	74·0	91·5	95·5	..	88·6	100·0
Chichawatni	..	100·0	..	..	25·8	65·0	..	4·8	82·4	..	71·4	84·1	..	90·9	91·7	..	92·8	72·2	..	95·4	73·3	..	93·2	..
Hafizabad	..	93·8	..	..	95·5	91·8	..	100·0	94·2	..	89·5	94·3	..	52·9	93·4	..	90·6	96·2	..	..	95·1	..	95·1	94·5
Arifwala	..	42·9	..	..	..	33·3	..	40·0	..	..	87·5	12·5	..	55·6	80·0	..	27·8	67·7	..	..	85·7	..	33·3	..
Nankana Sahib	..	100·0	..	..	100·0	100·0	..	90·8	100·0	..	92·9	100·0	..	88·9	97·9	..	85·7	100·0	..	..	100·0	..	..	..
Vihari	..	..	..	..	25·0	..	..	1·8	..	..	57·1	..	..	83·3	..	..	75·0	..	..	50·0	..	..	68·8	..
D. G. Khan	..	..	..	..	100·0	..	..	..	..	..	0·0	..	..	0·0	..	..	66·7	..	..	..	..	..	..	..
Sangala Hill	..	..	..	69·5	..	..	71·7	..	..	96·9	..	..	96·8	..	..	96·0	..	..	98·9	..	..	..	..	..

t will be seen from this table that the percentage *E. devastans* was low to start with at most of places and went on steadily increasing with advance of the season, until towards the end became the most predominating species. other point of interest is that species other n *E. devastans* were much more in evidence in th West Punjab (Arifwala, Khanewal, Vihari Multan) than in the rest of the province and was a matter of great interest to find out the se of this. This point will, however, be dealt h later.

Identification of other species

The technique adopted for the indentification species other than *devastans* was the same as cribed by Pruthi [1925]. It is evident that identification of the species by this method is ow and laborious process and it was, therefore, possible for us to examine each individual in collection. In order, however, to get a fairly urate idea of the proportionate number of the ious species, we selected at random 10 or 12 les of these species from each sample during 0 and 1941 and subjected these to the micros- ic examination. The samples of 1942 have been examined, but there is no reason to believe t these would be different from the samples of previous two years. The proportion of the ious species is given in Table II.

t will be seen from these data that *E. minor* *E. kerri* var. *motti* were the two most predomi- t species, the latter being more so than the ner. It would also be seen that *E. minor* was nd in greater abundance in Chiniot, Sargodha Bhalwal, while *E. kerri* predominated in the t of the province. It is unfortunate that with present state of our knowledge of the alter- ive host plants of *E. minor*, we cannot assign reason for the relative preponderance of this cies in these three places. It must, however, noted that these places lie adjacent to one ther and have similar soil and climate and are stly inhabited by the Jungle* Tribe, who have y rigid social customs and have the habit of wing large areas under fodders [Khan, 1938]. is probable that *E. minor* is a pest of some der crop, and comes on to cotton in the absence of its favourite host. This point, however, needs verification by careful observation.

The causes which led to the comparative abundance of *E. kerri* var. *motti* on cotton in early part of the season in certain localities and its virtual absence at the end of the season was the next point needing investigation. For this purpose a survey was made of the standing crops where cotton was growing and it was found that *guard* (*Cyamopsis psoralioides*) harboured a large number of jassids. The attack on this crop is really very heavy every year and *E. kerri* var. *motti* is found on it practically to the exclusion of every other species. It was, therefore, argued that cotton was only an alternative host plant of this insect, which preferred *guara* to cotton.

As is well known, *guara* is grown both for fodder and as a green manure crop. In the later case, the crop is allowed to grow rather luxuriantly and is buried in the soil any time before 15 September. When the crop is buried, the adult jassids then present on it migrate to other food plants. Thus in fields of cotton situated near *guara*, there is always a possibility of a larger number of these species being present than if no *guara* was grown near about. Also when *guara* is buried all the adult population will transfer itself on to cotton. The figures given in Table III are interesting in this connection.

Guara was buried during the interval between the first and second date of sampling during August and the drop in the percentage of *E. devastans* during this period can be explained by the invasion of *E. kerri* from *guara* to cotton. This drop was much more marked in the field situated near the *guara* crop than in the one away from it.

It is well known that *guara* as a green manure crop is grown in much larger proportions in the districts of Montgomery and Multan than in Lyallpur. At the British Cotton Growing Association Farm, Khanewal, from where the samples noted in Table I were taken, *guara* is grown on at least 2·5 acres per square (25 acres) every year, and this may explain the comparative abundance of *E. kerri* on cotton in the early part of the season at Khanewal.

It will also be clear from Table III that the comparative abundance of *E. kerri* var. *motti* did not continue for more than a fortnight after the removal of *guara*. In order to elucidate this point, experiments on oviposition and the development of

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The original inhabitants of the Canal Colonies of the jab. They are tall, well-built and always maintain a herd of milch cattle.

TABLE II

Proportion of different species of jassids collected from cotton during 1940 and 1941

Localities surveyed	JULY						AUGUST						SEPTEMBER						OCTOBER						NOVEMBER					
	Fortnight						Fortnight						Fortnight						Fortnight						Fortnight					
	I			II			I			II			I			II			I			II			I			II		
	E.M.	E.K.	E.P.	E.M.	E.K.	E.P.	E.M.	E.K.	E.P.	E.M.	E.K.	E.P.	E.M.	E.K.	E.P.	E.M.	E.K.	E.P.	E.M.	E.K.	E.P.	E.M.	E.K.	E.P.	E.M.	E.K.	E.P.	E.M.	E.K.	E.P.
Lyallpur	0	0	0	0	0	0	1	3	0	0	11	0	..	..	..	..	..	..	1	3	0	0	2	0	..	..	..	..	..	..
Chichawatni	..	..	..	3	8	0	3	9	0	1	0	0	0	2	0	2	0	0	..	..	..	1	0	0	..	..	..	..	..	..
Montgomery	3	0	0	..	..	..	0	22	0	0	9	0	2	8	0	2	5	0	0	2	0	..	..	..	..	..	..	..	..	..
Khanewal	11	0	0	10	13	0	2	20	0	0	25	0	1	11	0	0	12	0	4	17	0	3	18	0	1	1	0	..	..	..
Hafizabad	..	..	..	0	0	1	..	..	..	..	..	..	1	2	1	1	3	0	..	.	..	0	1	0	..	..	..	..	..	..
Chiniot	2	0	0	..	..	..	2	0	0	..	..	..	2	0	0	0	1	0	..	..	..	..	..	..	..	..	..	..	..	..
Hansi	0	0	1	..	..	..	7	1	0	6	11	0	0	2	0	1	0	0	3	16	0	0	7	0	..	..	..	..	..	..
Multan	0	4	0	2	4	0	2	19	0	1	20	0	1	23	0	0	20	0	4	13	0	1	6	0	..	..	..	..	..	..
Sargodha	..	..	..	2	4	0	7	0	0	8	4	0	0	1	0	9	3	0	10	3	0	..	..	..	..	..	..	..	..	..
Vihari	..	..	..	0	12	0	0	9	0	0	10	0	1	4	0	1	2	0	1	11	0	1	6	0	..	..	..	..	..	..
Arifwala	0	2	0	..	..	..	0	6	0	..	..	..	0	9	0	0	3	0	..	..	..	0	2	0	..	..	..	..	..	..
Bhalwal	..	..	..	..	..	..	16	2	0	10	0	0	2	1	0	8	4	1	..	..	..	2	1	0	..	..	..	..	..	..
Jhang	..	..	..	3	7	0	6	8	0	9	6	0	1	1	0	0	0	0	6	7	0	0	2	0	..	..	..	..	..	..
TOTAL	16	6	1	20	48	1	46	99	0	35	96	0	11	64	1	24	53	1	29	72	0	8	45	0	1	1	0	..	..	..

N.B.—E.M.=*Empoasca minor* E.K.=*Empoasca kerri* var. *motti* E.P.=*Empoasca punjabensis*

TABLE III

ercentage of E. devastans *Dist. in fortnightly collections from fields of cotton near and away from* guara *in 1941 at Lyallpur*

	JULY				AUGUST				SEPTEMBER				OCTOBER			
	I fortnight		II fortnight		I fortnight		II fortnight		I fortnight		II fortnight		I fortnight		II fortnight	
	Total	%E.D.	Total	%E.D.	Total	%E.D.	Total	%E.D.	Total	%E.D.	Total	%E.D.	Total	%E.D.	Total	%E.D.
Field of cotton contiguous to *guara* field	77	100·0	165	100·0	319	97·8	306	18·0	256	99·2	..	..	..	..	..	..
Field of cotton 1½ miles away from *guara* field	117	100·0	145	100·0	180	100·0	292	31·8	295	100·0	307	98·4	306	94·8	304	99·0

ıe nymphs of the two species, *E. devastans* and *. kerri* var. *motti* on *guara* and cotton were carried ut during 1942. The results of this investigaon are summarized below :

Seventy-two adults, both males and females, of *. devastans* and *E. kerri* var. *motti* were collected nd liberated on young leaves of *guara* and cotton nd the number of nymphs hatched out were ıter on counted. The necessary precautions bout the absence of oviposition on the particular eaves previous to the liberation of the adults ere carefully observed. The figures are given ı Table IV.

TABLE IV

viposition of E. devastans *and* E. kerri *var.* motti *on cotton and* guara

Species of jassids liberated	Plant on which liberated	No. of adults liberated	No. of nymphs hatched
. devastans . .	*Guara*	72	*Nil*
. devastans . .	Cotton	72	46
. kerri . . .	Cotton	72	3
kerri	*Guara*	72	269

It is seen from Table IV that *E. kerri* var. *ıotti* laid very few eggs on cotton while *E. devastans* ras not at all able to lay eggs on *guara*. *E. kerri* ras able to breed very freely on *guara* and this ıay be the reason of very large population of his pest found on *guara* every year.

Another experiment in which the development f the nymphs of these two species on cotton and *uara* was studied was performed during 1942. . certain number of first instar nymphs were iberated on young leaves and were carefully vatched. The number of adults that finally merged was also noted. In this case again, only hese young leaves which had been previously sleeved to prevent eggs being laid on them were used. The figures are given in Table V.

TABLE V

Development of the nymphs of E. devastans *and* E. kerri *var.* motti.

Species of jassid liberated	Plant on which liberated	No. of nymphs liberated	No. of adults which emerged
E. kerri var. *motti* .	*Guara*	165	81
Ditto. . .	Cotton	150	71
E. devastans . .	Cotton	150	80
Ditto . .	*Guara*	150	15

From Tables IV and V it will be seen that *E. kerri* var. *motti* lays very few eggs on cotton (and possibly the percentage of hatching is also very low), but the young nymphs have no difficulty in feeding on cotton and reaching maturity.

Here then, we have an explanation of the phenomenon of the rise in the number of *E. kerri* var. *motti* on cotton after the removal of *guara*. The adults of this species invade the cotton fields near *guara*, but the adults all die out soon after. As very few eggs are laid the species practically disappears from the cotton crop within a fortnight.

Small scale cage experiments, in which *E. kerri* var. *motti* was liberated on cotton plants in very large numbers to keep up a high degree of infestation, were performed during 1941 and 1942. It was invariably noticed that the death rate of the insect in the cages was very high and, therefore, daily liberation of a large number of fresh adults was necessary to maintain a high degree of infestation. It was, however, noticed that inspite of the high degree of infestation maintained artificially inside the cage, the characteristic symptoms of the attack of *E. devastans*—crinkling and reddening of leaves—did not develop on the plants.

Although no data on the loss in yield or deterioration in quality of fibre are available, it is considered that such losses cannot be high and, therefore, *E. kerri* var. *motti* should not be considered as a serious pest of the cotton plant in the Punjab.

It will also be seen from Table II that very few specimens of *E. punjabensis* were collected from cotton. It is suggested that this species is not as pest of cotton at all and the stray specimens recorded were only casual visitors.

Summary

Amongst the new species of jassids recently discovered it was found that *E. kerri* var. *motti* and *E. minor* were most commonly found on cotton plants in early part of the season and *E. punjabensis* was perhaps only a casual visitor to the cotton plant.

To the list of different species of jassids attacking cotton compiled by Afzal Hussain and Lal [1940] the name of *E. minor* may now be added.

So far as our present knowledge goes, both the new species mentioned above are not injurious to the cotton plant which is only their alternative host. The most favoured host plant of *E. kerri* is *guara*, and that for *E. minor* yet awaits determination.

Acknowledgement

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ON THE BIOLOGY OF THE VEGETABLE MITE (*TETRANYCHUS CUCURBITAE* RAHMAN AND SAPRA: FAM. TETRANYCHIDAE)

By Khan A. Rahman and Amar Nath Sapra, Entomological Laboratory, Punjab Agricultural College and Research Institute, Lyallpur

(Received for publication on 23 November 1944)

(With Plates I & II and ten text-figures)

The vegetable mite was first collected in November 1934 from *desi sem* (*Canavalia ensiformis*) at Lyallpur and was identified as a new species of the Genus *Tetranychus* by Mr R. J. Whitick of the British Museum and was described by Rahman and Sapra [1940,1] as *Tetranychus cucurbitae*.

T. cucurbitae is a very serious pest of vegetables and other crops in the Punjab and in view of its importance, a detailed study of its life history and habits was made and the results are presented in this paper.

Technique

For a study of the biology of this small-sized Arthropod, special technique had to be adopted. Therefore, the methods employed by McGregor and McDonough [1917] for a study of mites and Floyd-Smith [1931] for confining thrips on the leaves of the host plants, were tried, but none of these methods proved successful. On the other hand, the apparatus evolved by Storey [1928] for a study of the insect-vectors of plant viruses was, after some modification, found to be useful for studying the biology of this mite. This is briefly described below.

The apparatus (Fig. 1) consists essentially of four parts: two short tubes (*a*) and (*b*), a semicircular steel wire ring (*c*) which serves as a spring and glass tube (*d*) for confining mites. The two tubes (*a*, *b*) are formed at either extremity of a steel bar (*e*). A bamboo rod is passed through (*a*) and is fixed to the ground and the height at which the apparatus is to be adjusted is regulated with the screw(*s*).

One end of the ring (*c*) is soldered along the length of the tube (*b*), while its other end bears a cork which is provided with a padding of cotton-wool tied to it with muslin and this serves as a buffer for the leaf of the host plant. Through (*b*) passes the glass tube (*d*) and its lower end rests on the leaf over the padding. The edge of (*d*) which touches the leaf surface is thoroughly ground to make it smooth. The height of the tube is adjusted with the screw (*ss*) to secure correct pressure between the edge of the tube (*d*) and the leaf, between which is interposed a rubber ring to avoid injury to the latter by the former and to stop the escape of mite through loose contact of the two.

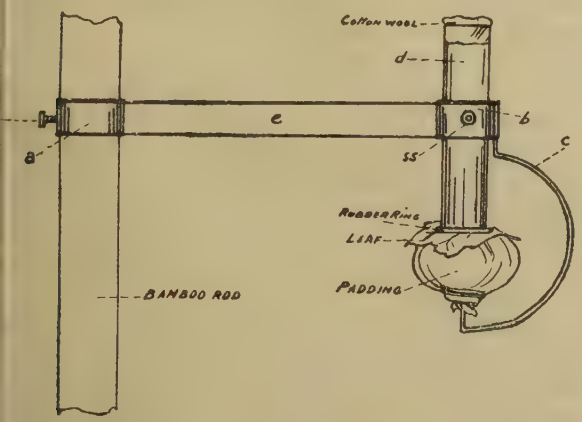


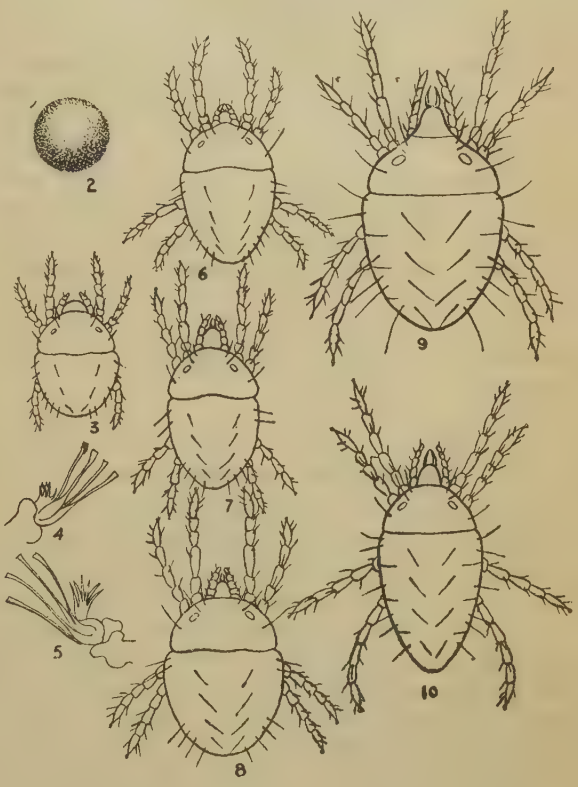
Fig. 1. Microcage

The tubes (*a*) and (*b*) are 1·8 cm. in length and 2.5 and 2.0 cm. in diameter respectively, the bar between them being 12.5 cm. long. The glass tube (*d*) is of 7.0 cm. length, 1.1 cm. internal diameter and 0·1 cm. thick walls.

Desi sem (*Canavalia ensiformis*) was used as host plant and it was grown under cover of thatching. The crop is in the field from April to December. The cover was essential as the mites could not stand direct sun, which made them restless and were generally lost in the cotton-wool plug on the upper end of the tube. Moreover, the afternoon temperature inside the glass tubes in the open, always, proved fatal for the mites after the middle of April.

Description of various stages

Egg (Fig. 2). Spherical, 0.112 mm. in diameter, transluscent when freshly laid and appears like a drop of honey in the web. Colour gradually changes to brown assuming a deeper tinge before hatching, when the area along the periphery becomes transparent and red eye-spots become visible.



Figs. 2—10

The vegetable mite (*Tetranychus cucurbitae* R. & S.)

Fig. 2. Egg ×91; Fig. 3. Larva ×91; Fig. 4. Tarsal claw (male) larva; Fig. 5. Tarsal claw (female) larva; Fig. 6. Male protonymph ×91; Fig. 7. Female protonymph ×91; Fig. 8. Deutonymph ×91; Fig. 9. Adult female ×91; and Fig. 10. Adult male ×91.

Larva (Fig. 3). Length 0.140-0.196 mm., width 0.126-0.154 mm. Almost spherical in outline and light amber in colour at hatching, becoming elongated later on and developing a greenish tinge and dark specks dorsolaterally with feeding. It has three pairs of legs.

Male and female larvæ distinguishable at birth, the tarsal claws of the first pair of legs, as in adults, ending in a whorl of teeth in case of male larvæ (Fig. 4) and in six hair like processes in female larvæ (Fig. 5). These characters persist in the later stages as well.

Protonymph (Figs. 6 & 7). Different from larva in being slightly bigger and with longer bristles on the dorsum and with four pairs of legs. The colour changes to deep green and dark specks on dorsum increase in size. Towards the end of this stage, the male and female protonymphs distinguishable apparently: male ones (Fig. 6) 0.210-0.290 mm. long and 0.161-0.175 mm. broad and more or less elongated while the female ones (Fig. 7) 0.210-0.280 mm. long and 0.162-0.182 mm. broad and more or less ovate.

Deutonymph (Fig. 8). Length 0.276-0.341 mm., breadth 0.198-0.240 mm. Only females pass through this stage, different from the previous stage in being bigger and genetalia being visible.

Adults. (Figs. 9 and 10). Have been described in detail elsewhere [Rahman and Sapra, 1940,1].

Distribution and food plants

Tetranychus cucurbitae has, so far, been recorded from Lyallpur, Gujranwala, Montgomery, Lahore and Sargodha districts of the Punjab, but because of the wide range of its host plants, it is most probably very widely distributed in the province. It has been collected from the following plants of which the first 13 suffer the most from its ravages : *tinda* (*Citrullus vulgaris* var. *fistulosus*), water melon, melon, different varieties of gourd, *ghia tori* (*Luffa aegyptiaca*), tomato, *desi sem* (*Canavalia ensiformis*), hollyhock, brinjal, cabbage, *mash*, *mong*, *moth* (*Phaseolus* spp.), peas, knoll-khol, cauliflower, *arhar* (*Cajanus indicus*), potato, onion, arum, poppy, swedes, turnips, brussel sprout, radish, cotton, *sunkukra* (*Hibiscus cannabinus*), lady's finger, different varieties of citrus, *darek* (*Melia azedarach*), *alyer* (*Dodonaea viscosa*), *jantar* (*Sesbania* sp.), *sheesham* (*Dalbergia sissoo*), berseem, shaftal, lucerne, *senji* (*Melilotus parviflora*), *maina* (*Medicago denticulata*), *maithey* (*Trigonella Foenum graceum*), soybeans (*Glycine hispida*), cow peas, sunn-hemp, rose, crab-apple, *karela* (*Momordica charantia*), celery, *dhodhak* (*Sonchus* sp.), sunflower, *chandni* (*Tabernaemontana coronaria*), *leli* (*Convolvulus arvensis*), railway creeper (*Ipomaea* sp.), petunia, *dodhak* (*Euphorbia* sp.), mulberry, clarkia, and sweet potato.

Life history

The males emerge a little earlier than the females and wander about on the leaf in search of a female. On coming across a resting deutonymph the male places its anterior pairs of legs on it and waits for its emergence, there being more than one males resting by a deutonymph. Its sexual behaviour and mode of mating resembles that of *Paratetranychus indicus* Hirst [Rahman and Sapra, 1940,2].

During April-September, the males generally die within 24 hr. after mating, but a few of them may live up to 48 hr. The unmated ones, however, live for 5-8 days during April-September and 9-20 days during March and October-December ; the females, on the other hand, live for 10-12 days and 14-25 days during the corresponding periods respectively.

Pre-oviposition period. Since the females are fertilized as they emerge, the pre-copulation period is negligible. The pre-oviposition period, however, varies with the temperature from less than 24 hr. (May-September) to 96 hr. (February-April and October-mid.-December), while the females may not oviposit even for a fortnight during the period from middle of December to end of January.

Oviposition. The eggs are laid at random in the web generally on the lower surface of the leaves from the beginning of March to the middle of December, the largest number being laid during April-October. The oviposition period lasts for 8-10 days during April-September and 12-20 days during March and October-December. During January-February eggs are laid very rarely, when there are long spells of bright sunny weather. The number of eggs laid is different for mated and unmated females. So the rate of oviposition varies with a temperature and the type of the female. The mated females laid a maximum of 13 eggs daily, the total number of eggs laid by them in their life time being 61-93 with a maximum during May-June and August-September, while the unmated ones laid a maximum of 9 and total of 33-59, the maximum being during April-June and August-September (Table I).

Post-oviposition period. The females, generally, die immediately after laying the last egg, this period extending to a maximum of 24 hr. during April-September, and 2-5 days during March and October-December.

TABLE I

Oviposition records of T. cucurbitae *R. & S.*

Month	Number of eggs laid by							
	Mated females				Unmated females			
	Total			Per day	Total			Per day
	Max.	Min.	Average		Max.	Min.	Average	
ch	80	66	75·0	1—4	50	33	44·0	1—3
il	86	65	77·5	5—12	57	43	52·0	5—8
y	93	61	79·8	10—13	56	42	50·8	5—9
ne	90	78	85·0	7—12	59	45	52·3	4—9
y	84	71	77·6	6—12	50	45	47·6	5—8
gust	90	75	82·0	7—11	54	47	51·3	4—9
ptember	89	72	82·3	8—10	58	47	51·8	3—6
tober	79	66	74·7	6—8	54	44	49·3	2—4
vember	80	61	72·1	1—5	52	37	46·0	1—3
cember	81	63	72·0	0—3	50	41	45·2	0—2

Hatching. The chorion splits on one side ong the circumference in a vertical plane. The va widens this opening by pushing the two es apart with its legs and comes out, leaving e egg-shell intact on the leaf surface.

The egg hatching is almost cent percent exoting from end of December to middle of Februy, when a majority of them fail to hatch.

The duration of the egg-stage varies with ason: eggs laid from middle of April to middle September hatch in 2½-3 days, those laid in rch to middle of April and middle of September nd of November, hatch in 3½-12 days, while se laid in January-February hatch in 30 ys (Table II).

TABLE II

Egg stage of T. cucurbitae *R. & S.*

Egg laid on	Egg hatched on	Duration (in days)
10-I (M)	9-II (M)	30
12-III (M)	20-III (M)	8
20-IV (E)	23-IV (E)	3
21-V (E)	24-V (E)	3
25-VI (E)	28-VI (E)	3
28-VII (E)	31-VII (M)	2½
30-VIII (E)	2-IX (E)	3
29-IX (E)	3-X (M)	3½
8-X (E)	13-X (M)	4½
21-X (M)	27-X (M)	6
7-XI (M)	14-XI (E)	7½
30-XI (M)	12-XII (M)	12

M) = Morning and (E) = Evening

Instars. The female mite passes through the following instars—egg: active larva-quiescent larva: protonymph-quiescent protonymph: deutonymph-quiescent deutonymph, the duetonymph instars being absent in case of male. When the larva or the nymph attains its growth, it fixes itself by thrusting its stylets into plant tissue and enters resting (quiescent) stage. During this period of rest, it neither feeds nor moves and its anterior pairs of legs lie parallel to each other and the rostrum. This stage is a sort of preparatory phase to the next stage. Its duration in each of the instars lasts for a few hours during March-November and for 1-3 days during December and 2-3 days during January-February.

The duration of the immature stages varies with the season: they separately occupy 1½-2, 3-6, 7½-9 and 20 days in males and 2½-3, 4-9, 10½-13 and 27 days in case of females during May-September, March-April and October, November-December and January-February, respectively.

Almost all the larvae hatching out from the eggs mature into adults, except about 10 per cent of them fail to moult successfully during May-June, especially in the first instar.

Life cycle. The generations overlap in nature and all stages of the mite are available during March-December. Under controlled conditions, as many as 32 generations were counted in course of a year.

TABLE III

Duration of immature stages of T. cucurbitae

Egg hatched on	Adults emerged on		Duration (in days)	
	Male	Female	Male	Female
9-II (M)	1-III (M)	8-III (M)	20	27
20-III (M)	26-III (M)	29-III (M)	6	9
6-IV (M)	9-IV (M)	11-IV (M)	3	5
23-IV (E)	26-IV (E)	27-IV (E)	3	4
24-V (E)	26-V (M)	27-V (M)	1½	2½
28-VI (E)	30-VI (E)	1-VII (E)	2	3
11-VII (E)	13-VII (M)	14-VII (M)	1½	2½
19-VIII (E)	21-VIII (E)	22-VIII (E)	2	3
17-IX (M)	19-IX (M)	20-IX (M)	2	3
2-X (M)	6-X (E)	7-X (E)	3½	4½
27-X (M)	2-XI (M)	4-XI (M)	6	8
14-XI (E)	22-XI (M)	25-XI (M)	7½	10½
12-XI (M)	21-XI (M)	25-XI (M)	9	13

(M) = Morning and (E) = Evening

The duration of the life-cycle depends upon the temperature. It occupied 4-7, 8½-12, 15-21 and 50 days in males and 5-9, 10-17, 18-25 and 57 days in females when the temperature °F. varied between 60·2-107·0, 52·2-88·6, 40·2-77·6 and 39·0-71·3, respectively (Table IV).

TABLE IV

Duration of life-cycle of T. cucurbitae *R. & S.*

Eggs laid on	Adults emerged on		Duration (in days)		Temperature °F.	
	Male	Female	Male	Female	Min.	Max.
10-I (M)	1-III (M)	8-III (M)	50	57	39·0	71·3
12-III (M)	26-III (M)	29-III (M)	14	17	52·2	83·6
2-IV (M)	9-IV (M)	11-IV (M)	7	9	60·2	91·7
20-IV (E)	26-IV (E)	27-IV (E)	6	7	70·2	105·5
7-V (E)	12-V (E)	13-V (M)	5	5½	81·0	106·5
21-V (E)	26-V (E)	27-V (M)	4½	5½	80·2	107·0
10-VI (E)	16-VI (M)	17-VI (M)	5½	6½	76·1	93·1
25-VI (E)	30-VI (E)	1-VII (E)	5	6	78·0	96·2
9-VII (M)	13-VII (M)	14-VII (M)	4	5	83·3	104·3
28-VII (E)	2-VIII(M)	3-VIII(M)	4½	5½	83·7	98·0
16-VIII(E)	21-VIII(E)	22-VIII(E)	5	6	77·5	96·0
30-VIII(E)	4-IX (E)	5-IX (E)	5	6	78·8	95·5
14-IX (M)	19-IX (M)	20-IX (M)	5	6	71·8	98·5
29-IX (E)	6-X (E)	7-X (E)	7	8	68·6	91·7
8-X (E)	17-X (M)	18-X (E)	8½	10	59·7	88·6
21-X (M)	2-XI (M)	14-XI (M)	12	14	53·9	82·5
7-XI (M)	22-XI (M)	25-XI (M)	15	18	45·8	77·6
30-XI (M)	21-XII (M)	25-XII (M)	21	25	40·2	69·6

(M) = Morning and (E) = Evening

WEB FORMATION

The females, when on fresh leaves, select concave area generally between two veins, whe they spin web and there may be large number small patches of the web spun by different female With the increased activity, these patches exten and coalesce with each other with the resu that there is ultimately a single sheet of we covering the entire surface. The web formatic is at first confined to surface initially infeste but is latter carried on indefinitely and on a sides and the web assumes the shape of a thic sheath covering the entire leaf (Plate II).

DISPERSAL

The females are responsible for fresh infesta tions. Before settling down on a leaf for feedin spinning and ovipositing, they move about o and along the veins or edges of the leaves, fro where they are easily dislodged by gusts of win and carried to fresh plants. These mites hav the interesting habit of collecting in nodule (Plate I), each of which may harbour as man as 1198 freshly emerged females, at the peak o the plant and thus expose themselves to th action of wind for dispersal. Whenever a blad of grass touches the infested plant, the mite collect at its apex. In the same field, the mite migrate from one leaf to the other through th contact of the two.

SEASONAL HISTORY

In the beginning of March, when the seaso warms up, the overwintered females becom active and begin to lay eggs, the first generatio being completed in about three weeks. Late generations follow in quick succession. Som individuals get carried to healthy plants throug contact or by wind and they start fresh infes tation. By end of April the pest is availabl on majority of the food plants mentioned above This is followed by a period of maximum activit up to July when the monsoon rains kill all stage except the eggs, which produce future progeny After cessation of rains the mites multiply rapidl and again become a pest in September-Octobe With the fall in temperature after October th population gradually declines, till by the middl of December mostly gravid females remai

Mode of dispersal

Damaged *Tinda* leaf

Web removed

Web intact

ich overwinter. These females feed and do netimes lay eggs whenever the season becomes rmer. In all 32 generations are gone through ring the course of year and those during March-cember overlap.

The annual calendar of the activities of this t is as under :

1. *March-April*—Quick multiplication on weeds, cabbage, knoll-khol and holly-hock; migration to other plants.
2. *May-mid. July*—Activity at its zenith on large variety of plants especially cucurbits and other vegetables.
3. *Mid. July-August*—Mites rare except the eggs, available on cucurbits and sweet potato.
4. *September-October*—Again active especially on *tinda*, *desi sem* and pulses.
5. *November-mid. December*—Population on decline, available on cauliflower, cabbage, knoll-khol and *desi sem*.
6. *Mid. December-February*—Mostly gravid females on cabbage, knoll-khol, holly-hock and weeds.

Parthenogenesis

Parthenogenesis is common in this species o, the parthenogenetically developed progeny sisting of males only. The fertilized females, wever, give rise to a progeny, which has about per cent females.

Sex ratio

The sex ratio is 50 : 50 from May to September. October the number of males goes up, but dually declines during the subsequent months, much so that the males are practically absent ring January. Due to the paucity of males ring December-January the majority of females nain unmated and reproduce parthenogene-ally during March-April and thus the le population is higher during these nths.

Table V gives the sex ratio in different months. e counts were made on ten leaves of holly-hock, *da*, *ghia-tori*, or lady's finger in the later half very month.

Table V

Sex ratio in T. cucurbitae *R. & S.*

Month	No. of males	No. of females	M : F
January	1	209	0·5 : 99·5
February	27	428	6 : 94
March	243	130	65 : 35
April	481	285	61 : 39
May	306	323	49 : 51
June	338	370	48 : 52
July	63	81	44 : 56
August	85	90	49 : 51
September	69	84	46 : 54
October	123	90	58 : 42
November	25	111	19 : 81
December	3	166	2 : 98

Nature and extent of damage

The mites suck plant sap with their stylets and their places of feeding appear as white spots on the leaf surface. With the increase in the intensity of attack the white spots increase in number and gradually coalesce with each other finally producing large patches. The leaves loose their green healthy colour (Plate II), gradually wilt, dry and fall off. This decreased vitality and leaf drop effect growth, flowering and fruiting and a poor or no crop results. In some of the host plants, especially *desi sem* (*Canavalia ensiformis*), the damaged portions of the leaves become rust-red in colour.

In severe cases of infestation, the web spun by these mites is profuse and very thick (Plate II) and covers the foliage on all sides. The dust particles blown by wind during May-June, when mite attack is at its worst, are deposited in the web. The web together with the soil particles smothers the leaves and this was tested experimentally : leaves of *tinda* (*Citrullus vulgaris* var. *fistulosus*) were infested with 25 gravid females in the beginning of June, in some cases the web spun by the mites was broken daily, while in others it was left to develop undamaged, and it was seen that the leaves dried in 19 days where the web was not broken and 28 days where the web was broken. In most of the cases the attacked plants do not bear any fruit.

Summary

Tetranychus cucurbitae is the most serious and commonest of the recorded plant mites. It has been collected from about 55 plants and because

of the wide range of its hosts, it is probably extensively distributed in the province.

The technique for confining mites individually on the leaves is described and description of the immature stage is given. It is shown that the duration of oviposition, pre-oviposition and post-oviposition periods as well as that of egg and larval stages depends upon the season. During the active period (April-mid. October) the life cycle is completed in 4-8½ days in males and 5-10 days in females. The mated and unmated females laid 61-93 and 33-59 eggs respectively and progeny from unfertilized eggs comprised of males only. The seasonal history calendar is given and it is shown that the damage by the pest is at its peak during May-mid. July and September-mid. October. The pest has been observed to go through 32 overlapping generations during the course of a year and the females predominate except during March-April and October.

The pest is distributed through freshly emerged females and mode of dispersal is described. The attacked leaves loose green colour, dry and fall off and the attacked plants bear no or poor fruit.

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RELATIVE AVAILABILITY OF DIFFERENT NATURAL AND ARTIFICIAL PHOSPHATES IN CALCAREOUS SOILS

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(With Plate III)

Phosphorus is one of the most important of the principal plant-food materials in which Indian soils are usually deficient. Taking India as a whole there are sufficient indigenous supplies of phosphatic manures from all sources consisting of raw mineral phosphates, such as Trichinopoly nodules and apatite, bones, and fish guanos to meet the present demands, although there are isolated localities where the question of the supply of superphosphate appears to be important. The superior advantage of compound fertilizers like ammophos, diammonphos, leunaphos, niciphos, etc., recently appearing in the market under various trade names, is to be ascribed to their additional constituent of nitrogen besides phosphorus.

Calcareous soils in the Gangetic alluvium around Pusa in Bihar contain from 30 to 40 per cent of calcium carbonate. They are particularly deficient in available phosphates for most of the common agricultural crops and respond well to phosphatic fertilizers under suitable cultural conditions. Therefore, in order to determine the relative availability of different natural and artificial phosphates, a series of pot experiments was carried out in the winter of 1933 with Pusa calcareous soil containing 33 per cent of calcium carbonate.

Four pots of similar dimensions, 9 in. in diameter and 12 in. high, formed a group and received similar treatment. Each pot contained 15 kilos of air-dry soil and 16 per cent of moisture was maintained in the soil throughout the experiment. A basal dressing of potash and nitrogen was given to all the pots at the rate of 80 and 100 lb. per acre as sulphates of potassium and ammonium respectively. Allowance was made for either nitrogen or potash contained in bonemeal, ammonium or potassium phosphate. Different phosphates were applied to different groups of pots at the rate of 50 mg. of P_2O_5 per kilo of soil or 100 lb. of P_2O_5 per acre. There was a group of control pots for comparison, where no phosphate was added. Bonemeal used was obtained by treating raw bones with a solution containing 1·5 per cent caustic soda and 1 per cent common salt for 70 days and then crushing them fine after washing with water and drying. Apatite and Trichi-nodules were finely pulverized.

Mustard was sown on 11 November 1933 and the crop harvested on 6 March 1934. The mean yields of grain are given in Table I along with

eir statistical examination by Fisher's [1932] alysis of variance.

TABLE I

he relative availability of different phosphates as reflected in the yield of mustard in a calcareous Pusa soil and their classification on the basis of their yields

oup	Phosphatic fertilizers	Mean yield in gm.	Per cent increase over control
I	Control	6·05	..
II	Aluminium phosphate, $AlPO_4$, $3H_2O$	7·18	19·0
	Apatite	7·40	22·3
	Trichi-nodules . . .	8·00	32·2
	Bonemeal	8·28	36·8
	Potassium phosphate, KH_2PO_4	8·40	38·8
	Sodium phosphate, Na_2HPO_4, $12H_2O$	8·50	40·5
II	Magnesium ammonium phosphate, $Mg\,NH_4PO_4$, $6H_2O$	9·45	56·2
	Iron perphosphate, $FePO_4$, $2H_2O$	9·50	57·0
	Dicalcium phosphate, $CaHPO_4$, $2H_2O$	9·78	61·6
	Tricalcium phosphate, $Ca_3(PO_4)_2$	9·85	62·8
IV	Ammonium phosphate, $(NH_4)_2HPO_4$	12·40	105·0
	Superphosphate . . .	13·75	127·3

Standard error for comparison of mean yields . . .	=0·817
Critical difference for 1 per cent	=2·21
Critical difference for 5 per cent	=1·65

From Table I it is evident that all the treated ts have produced higher crop returns than the ntrol according to the quality of the phosphatic rtilizer employed. The differences in mean yields grain between the control and every other treatent are highly significant being greater than the itical value of difference except in the cases of patite and aluminium phosphate. The higher op yields with these two fertilizers were not gnificant. Trichi-nodules give significant results r 5 per cent, and the rest even for one per cent vel of significance. Superphosphate and mmonium phosphate give individually the most gnificant results over the rest, but between them ere is no significance. Thus, except apatite nd aluminium phosphate, all the other phosnatic fertilizers are made available in calcareous ils and can effectively supply the phosphatic utrition of plants.

The fertilizers may be classified into four broad groups according to the magnitude of the yields obtained, as shown in the first column of Table I.

Eleusine coracana (vernacular *ragi, marwa*) was grown as the next *kharif* (summer) crop in 1934 in these very pots in order to study the residual effect of these fertilizers. Only nitrogen at the rate of 50 mg. per kilo of soil as ammonium sulphate was renewed in all the pots, but no potash or phosphates were added. Eight seeds of *ragi* were sown in each pot on 14 June 1934. A month after, the *ragi* seedlings were thinned to four in each pot. The rejected seedlings numbering 12 from each group of pots were weighed in order to find out the variation in growth under different phosphatic fertilizers. The results are set forth in Table II.

TABLE II

Fresh weight of ragi *seedlings of about four weeks' growth under different phosphatic fertilizers*

Original treatment	Fresh weight in gm.	Per cent increase or decrease over control
Control	5·10	..
Bonemeal	9·60	+88·2
Apatite	6·40	+25·5
Trichi-nodules . . .	3·60	—29·4
Magnesium ammonium phosphate	4·40	—13·7
Tricalcium phosphate . .	10·40	+104·0
Dicalcium phosphate . .	7·15	+40·2
Superphosphate . . .	9·50	+86·3
Ammonium phosphate . .	15·30	+200·0
Sodium phosphate . . .	21·25	+316·7
Potassium phosphate . .	12·70	+150·0
Iron perphosphate . . .	3·70	—27·5
Aluminium phosphate . .	7·15	+40·2

From Table II it is evident that except Trichinodules, iron and magnesium ammonium phosphates, all the other phosphatic fertilizers have produced better vegetative growth than the control. All the water-soluble fertilizers except superphosphate have given the best residual effect. Next comes in order the group representing super, bonemeal and tricalcium phosphate, and last of all are apatite, aluminium and dicalcium phosphates.

This gro uping of the fertilizers for the residual effect does not, however, exactly fit into their classification as shown in Table I for the primary

effect except in the case of tricalcium and ammonium phosphates. Aluminium phosphate and apatite whose primary effect was not significant on the yield of mustard, have shown an appreciable residual effect. On the other hand, Trichi-nodules, iron and magnesium ammonium phosphates, whose primary effect was considerable, have not only failed to show any residual effect, but produced a lesser vegetative growth than even the control.

A photograph of *ragi* seedlings of about seven weeks' growth taken on 4 August 1934 from representative pots is given in Plate III, fig. 1. It indicates the variation in growth due to different phosphatic fertilizers from left to right in the order given in Table II.

This variation in vegetative growth was not, however, reflected in the mean yields of grain given in Table III, when the crop was harvested on 24 September 1934.

TABLE III

The residual effect of different phosphatic fertilizers as reflected in the yield of ragi *grain in Pusa Calcareous soil*

Original treatment	Mean yield in gm.	Percentage variation over control
Control	12·80	..
Bonemeal	10·13	—20·9
Apatite	14·93	16·6
Trichi-nodules	12·95	1·3
Magnesium ammonium phosphate	13·68	7·0
Tricalcium phosphate	21·68	69·4
Dicalcium phosphate	16·25	27·0
Superphosphate	19·35	51·2
Ammonium phosphate	17·48	36·6
Sodium phosphate	22·60	76·6
Potassium phosphate	20·80	62·5
Iron phosphate	20·30	58·6
Aluminium phosphate	22·53	76·0

Standard error for comparison of mean yields	=1·095
Critical difference for 1 per cent	=2·97
Critical difference for 5 per cent	=2·22

From Table III it is evident that all the phosphates except bonemeal have produced a higher crop return than the control. The differences in mean yields of grain between the control and every other treatment are highly significant being greater than the critical value of difference even for one per cent level of significance except in the case of bonemeal, apatite, Trichi-nodules, and magnesium ammonium phosphate. Among the latter, bonemeal gave altogether negative results when compared with the control and the rest slightly higher yields which were not significant. Aluminium phosphate whose primary effect on mustard was not significant, gave about the best residual effect showing that it was rendered available in the soil after some lapse of time. On the other hand, Trichi-nodules, bonemeal, and magnesium ammonium phosphate, whose primary effect was appreciable, showed a marked deterioration and produced a poor yield of *ragi*. Considerable residual effect of the rest of the fertilizers is, however, manifested in the higher crop yields than the control. Iron and tricalcium phosphates have uniformly maintained their good effect in both the crops. Sodium and potassium phosphates have better residual effect than the primary, but the reverse is the case with super and ammonium phosphate.

The solubility of phosphatic fertilizers in a 2 per cent solution of citric acid is considered to be a measure of their availability in a soil. It was determined in order to find out its relationship with crop yields, if any. The results are arranged in Table IV according to the increasing order of solubility or availability values of the phosphates.

It is evident that no relationship is found between the yields of mustard or *ragi* grains at harvest and solubility or availability values given in the third column of Table IV. In the case of *ragi*, however, some relationship is exhibited between its vegetative growth at early stage as detailed in the last column and the solubility values of the last five fertilizers. This is not of course exactly proportional; for, although the solubility values of these five manures are identical, the corresponding vegetative growth is not the same, but varies over a wide range. Even this relationship is not maintained at the time of harvest.

These results, however, indicate that solubility is not the dominating factor of availability of fertilizers in a soil. Biochemical activity of a soil, colloidal properties of the manures according to the hypothesis of Comber [1922], feeding power of plants, and base exchange phenomena along with other unexplored factors perhaps play an important role in rendering the phosphatic fertilizers available to crops grown in a particular soil.

FIG. 1. Growth of *ragi* seedlings under various phosphatic fertilizers

FIG. 2. Growth of oat seedlings in the field under various phosphatic fertilizers

TABLE IV

Relationship between solubility values of various manures and crop yields in a calcareous soil

Kind of phosphates applied	Per cent total P_2O_5	Per cent of total P_2O_5 soluble in citric acid	Per cent variation of grain over control		Per cent growth variation of *ragi* seedlings over control
			Mustard	*Ragi*	
on phosphate	36·23	11·20	57·0	58·6	—27·5
patite	19·14	12·08	22·3	16·6	25·5
ichi-nodules	19·74	23·24	32·2	1·3	—29·4
calcium phosphate	36·13	54·68	61·6	27·0	40·2
perphosphate	21·40	75·84	127·3	51·2	86·3
agnesium ammonium phosphate	32·48	81·47	56·2	7·0	—13·7
uminium phosphate	38·37	94·71	19·0	76·0	40·2
onemeal	23·40	99·49	36·8	—20·9	88·2
icalcium phosphate	43·13	100·00	62·8	69·4	104·0
otassium phosphate	52·17	100·00	38·8	62·5	150·0
mmonium phosphate	53·29	100·00	105·0	36·6	200·0
odium phosphate	25·25	100·00	40·5	76·6	316·7

In order to test the conclusions with regard to he relative availability of different phosphatic rtilizers arrived at from pot experiments, field ials in the Punjab Experimental Area of the Pusa arm were undertaken in the winter of 1934. xperiments were laid out in three adjacent 1/4 cre plots, each of which was subdivided into 18 qual sub-plots of 1/72 acre each measuring about) ft. north to south and 20 ft. east to west. A asal dressing of potash and nitrogen at 80 and 0 lb. per acre as sulphates of potassium and mmonium respectively was given to all the sub-plots, allowance being made for the amount of nitrogen contained in the case of bonemeal and niciphos. Phosphatic fertilizers were applied 4 in. below the surface by deep ploughing at 100 lb. of P_2O_5 per acre according to the following plan based on controlled randomization of nine treatments of six replications each.

The treatments were control (C), apatite (A), bonemeal (B), disodium hydrogen phosphate (D), sodium metaphosphate (M), niciphos (N), sodium pyrophosphate (P), superphosphate (S) and Trichinodules (T).

PLAN

West

	Plot No. 29				Plot No. 25				Plot No. 21			
	SHALLOW			DRAIN			SHALLOW			DRAIN		
ROAD	S	P	T	ROAD	M	N	D	ROAD	B	C	A	ROAD
	C	B	D		A	P	S		T	M	N	
	N	A	S		T	C	M		P	D	B	
	T	C	P		N	D	B		A	S	M	
	M	N	B		S	A	P		D	T	C	
	A	D	M		B	T	C		N	P	S	
	SHALLOW			DRAIN			SHALLOW			DRAIN		

South North

East

Oat seeds were sown on 3 November 1934 in 30 lines east to west in each sub-plot at the rate of 40 lb. per acre. Owing to the paucity of germination there were gaps in certain lines, where seeds were resown. Twelve weeks after sowing, five representative plants were collected from each sub-plot. Thirty such plants thus taken from six sub-plots of each treatment were bundled together, weighed and photographed. (Plate III, fig. 2.)

The variation in vegetative growth as reflected in Plate III, fig. 2, is shown in Table V.

TABLE V

Fresh weight of oat plants of twelve weeks' growth in plots under different phosphatic fertilizers

Treatment	Fresh weight of 30 plants in gm.	Per cent variation over control
C = Control	890	..
A = Apatite	690	—22·5
B = Bonemeal	720	—20·0
D = Disodium hydrogen phosphate	1,630	+83·2
M = Sodium metaphosphate	2,900	+225·7
N = Niciphos	1,890	+112·4
P = Sodium pyrophosphate	1,420	+60·0
S = Superphosphate	1,000	+12·4
T = Trichi-nodules	750	—15·7

It then became of interest to know how this variation in vegetative growth was reflected in the grain at harvest.

During harvest in March 1935, one row of plants from the surrounding border of each sub-plot was rejected. Mean yields of grain are given in Table VI along with their statistical examination according to Fisher's [1932] analysis of variance.

It is evident that the differences in mean yields of grain between the control and every other treatment are highly significant being greater than the critical value of difference even for one per cent level of significance, except in the case of indigenous phosphatic fertilizers, e.g. apatite, Trichi-nodules and bonemeal. Apatite and Trichi-nodules gave negative results and bonemeal hardly better yield, when compard with the control. Of the manures which have produced significantly better yields than the control, sodium metaphosphate heads the list with 31 per cent increase, and the rest give almost the same

TABLE VI

Mean yields of oats grain in field experiments with Pusa calcareous soil under various phosphatic fertilizers

Treatment	Mean yield in lb.	Per cent variation over control
C = Control	24·50	..
A = Apatite	23·75	—3·1
B = Bonemeal	25·00	+2·0
D = Disodium hydrogen phosphate	30·13	+23·0
M = Sodium metaphosphate	32·18	+30·9
N = Niciphos	30·88	+26·0
P = Sodium pyrophosphate	30·73	+25·4
S = Superphosphate	30·73	+26·2
T = Trichi-nodules	21·80	—11·0

Standard error for comparison of mean yields = 2·075
Critical difference for 1 per cent = 5·61
Critical difference for 5 per cent = 4·19

increase ranging from 23 to 26 per cent over the control. In pot experiments, however, with mustard, the primary effect of Trichi-nodules and bonemeal on crop yield was significant but not the residual effect, whereas apatite gave no significant yield. In the present instance, metaphosphate gave the best vegetative growth and the indigenous phosphates less growth than even the control. This is fully reflected in the grain too. With regard to the rest of the phosphatic fertilizers, the differential vegetative growth at the early stage of the oat plants given in Table V is not reflected in the grain at harvest. For, all these phosphates give almost the same crop yield as shown in Table VI, which are, however, quite significant, when compared with the control.

It would thus appear from the cropping results of pot and field experiments that indigenous phosphates like bonemeal, apatite and Trichi-nodules proved very refractory in calcareous soils and were not rendered available to plants in field trials, whereas the last two became somewhat available in their primary effect in pot experiments with mustard, but their residual effect with *ragi* was not significant at all. Iron and aluminium phosphates which are normally taught to be unavailable to plants, proved quite useful as phosphatic fertilizers, the latter showing better residual effect than the primary. Sodium meta- and pyro-phosphates, the two new products

pared in the laboratory, show great promise phosphatic fertilizers for calcareous soils. aphosphate proved the best of all the phostic fertilizers tried in the present experits. The effect of the remaining phosphates h in pot and field experiments is quite reciable.

Summary and general conclusions

series of pot experiments in a highly calcareous a soil was conducted with indigenous phostes like bones, apatite, and Trichi-nodules as as artificial phosphates of iron, aluminium, ium, magnesium, sodium, potassium and nonium.

The cropping results with mustard showed 19 127 per cent higher yield of grain than the trol according to the quality of phosphatic ilizers used. The fertilizers could be classified four broad groups according to the magnitude ields obtained.

Eleusine coracana (vernacular *ragi*, *marwa*) was wn as the *kharif* (summer) crop in the same pots order to study the residual effect of these nures. Iron and aluminium phosphates which normally taught to be unavailable to plants, proved quite useful, the latter showing better residual effect than the primary.

The examination of solubility or availability values of these manures by extraction with 2 per cent citric acid solution showed some relationship between them and crop growth of *ragi* at its early stage only with five of these manures, but such relationship was finally non-existent, when the respective crops were harvested. Solubility is not, therefore, the dominating factor of availability of phosphatic fertilizers in a soil.

Field experiments with oats showed that indigenous phosphates like bonemeal, apatite and Trichi-nodules prove quite refractory in calcareous soils and sodium meta- and pyro-phosphates, newly used as phosphatic fertilizers, show great promise in calcareous soils. The metaphosphate proved the best of the remaining phosphates tried, e.g. niciphos, superphosphate, sodium phosphate and sodium pyrophosphate, all the latter giving almost identically satisfactory crop yields.

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CERATOSTOMELLA DISEASES OF PINEAPPLE

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(With Plate IV and five text-figures)

EAPPLE [*Ananas comosus* (L.) Merr.] (=*A. us* Lindl.) is grown extensively in the Surma ey and the Hill Districts and its cultivation xtending to new land every year. Three ases of this crop due to *Ceratostomella paradoxa* Seynes) Dade [=*Thielaviopsis paradoxa* Seynes) v. Höhn.] have been found widead and occur throughout the pineapple ving tracts. These diseases are: leaf-spot, -rot and fruit-rot. Careful survey and investions made during the last four years have aled that leaf-spot causes negligible damage, -rot destroys 4 to 10 per cent of the plants fruit-rot 3 to 15 per cent of the fruits. Fruit has been found to do more damage in storage during transit than in the fields. The local Joldhup variety has been found more susceptible to fruit-rot than the imported varieties, Giant Kew and Queen. During transit, in a few cases, Joldhup variety has been found to lose more than 50 per cent of the fruits.

Mehta [1940] reported a stem-end and soft-rot due to *C. paradoxa* in pineapples brought to the Cawnpore market from Gorakhpur in the United Provinces. There is no other mention of the occurrence of these diseases from any other part of India. In other countries these diseases have been noted from an early time. Larsen [1910] noted these in Hawaii, Patterson *et al.* [1910] in the United States of America, Roldan [1925] in the Philippine Islands, Dickson [1929] in Australia, Boedijn [1929] in Sumatra, Johnson

[1931] in the Antilles, Central America and Puerto Rico, Shepherd [1935] in Mauritius, Parham [1935] in Fiji, Bell [1936] in Queensland and Traub and Robinson [1938] in Mexico. Thus it is manifest that these diseases are quite wide-spread. Even in India, careful surveys are likely to show that they are prevalent in more localities than we know at present.

Symptoms of the diseases

(i) *Leaf-spot.* The spots appear on any part of the leaf. They vary considerably as regards size, shape and colour. Many are large and white and are noticeable from a long distance while others are small and inconspicuous. In typical mature spots there is a straw coloured central area surrounded by a dark margin. Very often there is a dark center within the straw coloured area or dark blotches due to the formation of the black macrospores within the tissue. The internal tissue is soft and decayed at first but this soon dries out leaving the injured area dry and shrunken. In early stages the spots may be olive brown in colour and fairly regular in outline or they may be white and irregular from the start.

(ii) *Base-rot.* Pineapple suckers sometimes fail to develop normally after planting out. Such plants remain more or less at a standstill and cease to produce new growth. Later a yellowing and withering of the leaves commence and the sucker eventually dies. The plants exhibiting these symptoms will be found to be loose in the ground and closer examination will disclose black area of rot invading the base of the stem. The rot gradually extends until the whole of the lower part of the sucker together with some of the lower leaf bases may be involved. The plant is then liable to break off at the ground level. Older plants are also sometimes affected with this trouble, the symptoms being very similar to those described above.

(iii) *Fruit-rot.* The fruit tissue when affected takes on a water-soaked appearance, becomes a shade darker yellow than the normal tissue and has a characteristic odour. It is very soft and juicy even in the early stages of decay, and becomes so thoroughly disintegrated that it yields to the slightest pressure. Another and perhaps a more accurate means of distinguishing the rot is a black discolouration that takes place on the surface of diseased tissue when this has been exposed to the air. This black discolouration consists of the dark coloured macrospores of th fungus. They develop so freely that the entir exposed surface becomes quite black in appearanc In advanced stages of the rot they may occu within the fruit especially along the core, but i most cases it is necessary to cut open the pine apple and expose the affected tissue to atmos pheric conditions for about 24 hours before th black spores become apparent. In the final stage of rot, when the fruits are going to pieces, th whole fruit becomes covered with these spores Plate IV shows the symptom of the disease.

Pathogenecity

The following inoculation experiments wer carried out by the pure culture of the fungus :

(i) *Leaves.* A large number of leaves wer selected. They were either wounded by steril scalpels or left without wounds. The spores o the fungus were then either sprayed on thei surfaces or bits of culture containing the myceliur and spores of the fungus placed at the wounde or other selected unwounded places. Leave wounded before inoculation only took infection On uninjured tissues the fungus grew under mois conditions but could not penetrate the leaf. I appears therefore that in the field, infection take place through surface wounds made by insect and by the spines and sharp edges of the neigh bouring leaves.

(ii) *Base.* Seventy crowns were inoculated wit the fungus by injecting the fungus into the tissu at the base of the crown. Every one becam affected with base-rot. When the fungus wa applied over the surface of the tissue the plant were also affected. It was further demonstrate by experiments that infection may take plac directly from the fungus that is present on th surface of the tissue at the time of planting. I the preliminary experiment successful infection were also obtained simply by inoculating the so before planting. Therefore it is evident that th fungus present in the soil about the plantin material may be responsible for infection. Whe the rot sets in before the cuttings are planted th infection takes place from fungus spores tha happen to lodge towards the base of the plantin material and which by virtue of moist condition are induced to germinate.

(iii) *Fruit.* Both green and ripe fruits we subjected to infection. Fruits to be inoculate were disinfected with 1:1000 mercuric chlorid

tion and then washed thoroughly with sterile
r. The fruits were then either sprayed with a
e suspension of the fungus or spores and hyphae
ne fungus (bits of culture) applied at selected
es on the wounded and unwounded surfaces
he fruits. The inoculated fruits were kept in
t chambers. From two to five days after
ulation the inoculated fruits showed the
acteristic symptoms of the disease.
oculation experiments carried out on fruits
conclusively proved that the fungus is
ble of infecting pineapple fruits with and
out the help of wounds. It has further been
ght out that the fungus can affect green pine-
e as readily as the ripe one.
was observed that when spore suspensions in
le water were sprayed over the fruits in each
typical soft rot developed not from any single
t in the surface as was the case when the
us had been inoculated into a puncture but
the entire fruit at once affecting the tissue
ining the surface and travelling gradually
rds the centre. The point of infection in
cases seems to be in the crevices between the
vidual fruits or berries which make up the
apple, for on examining the fruits infected by
ce inoculation it was found that the rot had
riably proceeded from the bottom of these
ces into the surrounding tissue.
ch is probably the usual avenue of entrance
wed by the fungus in attacking fresh fruits
ng transit or in storage. The transpiration
the fruits produces a moist atmosphere which
ly permits spore germination and consequently
ce inoculation takes place. The cut end of
stem also affords an avenue of entrance for
fungus under these conditions.
the field much of the infection takes place
gh wounds in the fruit surface such as insect
tures, sun scald, fruit cracks and injuries
ted by animals or implements during the
us field operations. The dry atmospheric
ition in the field prevents surface inoculation
large extent. Only the very base of the
it seems affords such conditions as make
ce infection in the field possible. At the
of the fruit a chamber is formed between the
s on the stem and the base of the pineapple
he fungus spores which lodge here are protect-
om the sunlight and are often surrounded
sufficiently moist atmosphere to permit of
germination.

Causal organism

(*a*) *Growth in culture*

The fungus was grown on a large number of media; potato-dextrose agar, oat meal agar, pineapple decoction, maize meal agar, pineapple fruit cylinders and steamed pineapple leaf. On all these substrata the fungus showed good growth. The cultural features of the fungus on all these various culture media did not differ greatly. The predominant snowy white growth of the cultures 24 hours old turning to grayish green, dark green and finally black as they became older was the conspicuous character of the fungus. The production of microconidia in cultures 24-48 hours old, followed later by the formation of macro-conidia was observed to take place in all cultures. The fungus showed such rapidity of growth in all cultures that the entire surface of the substrata was covered with the fungus growth after four days. The fungus however showed a tendency to produce less profuse growth on steamed pineapple leaf than on the other media.

(*b*) *Microscopic features*

Mycelium. The mycelium of the fungus is hyaline, granular with a greenish tint frequently branched and septate. It becomes ragged and thick-walled with age. The breadth of the hyphae ranges from 2·5 to 10·5μ.

Conidiophores. The conidiophores are of two types (Figs. 1 & 2). One bears macro-conidia and the other bears micro-conidia. The conidiophores bearing macro-conidia are more or less club-shaped, septate, hyaline and sometimes granular. The number of septa varies from one to three. The length measures from 21·9 to 73·2 μ. They produce from 2 to 40 conidia in chains.

The conidiophores bearing micro-conidia are hyaline or may be granular tinged with light green colour. Their form is very characteristic. The basal portion is swollen but abruptly constricted at the point of attachment to the mycelium and tapers towards the apex presenting a candle-stick shape. The micro-conidiophores are septate. The septation varies from 2 to 13. The frequency of septation depends upon the length of conidiophores. The conidiophores vary from 34·9 to 250 μ in length. The micro-conidiophores produce two types of conidia which form chains of from 2 to 75.

Both the macro- and micro-conidiophores may be produced laterally from the same mycelium.

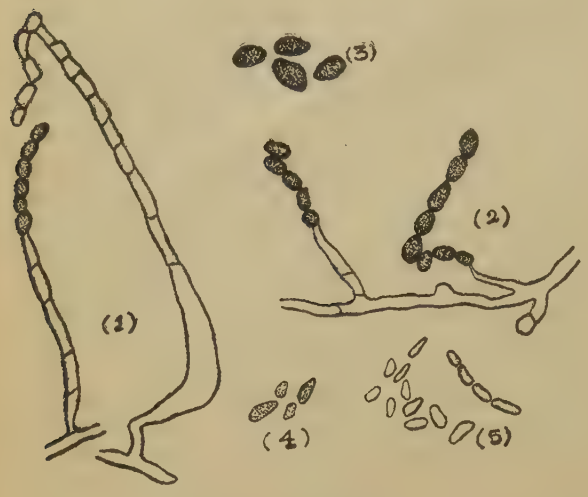


Fig. 1. Micro-conidiophores ;
,, 2. Macro-conidiophores ;
,, 3. Macro-conidia ;
,, 4. Micro-conidia (light brown) ;
,, 5. Micro-conidia (hyaline)

Macro-conidia. The macro-conidia (Fig. 3) are light to dark brown, smooth, ovoid or ellipsoidal, having thick walls. They are provided with strongly refractive contents and very often with one or more large vacuoles. The macro-conidia are pushed up from the conidiophores when new spores are produced below and finally form chains consisting of as many as 30 spores. The size of the macro-conidia ranges from 14-19×10-14 μ. On some media they form in such great profusion that they give the media an almost jet black appearance.

Micro-conidia. The micro-conidia are of two types (Figs. 4 & 5) and can be easily distinguished from each other on account of the sizes, form and colour. One is light brown and the other is hyaline. Both forms of micro-conidia are borne on the same kind of conidiophores.

The micro-conidia of light brown colour are barrel-shaped or ovoid, rarely cylindrical with thick wall varying from 9·4-19×4-6 μ.

The hyaline micro-conidia are cylindrical with thin wall varying in size from 9-12×3·5-5 μ.

Both types of micro-conidia are formed in the same manner. They develop inside the hyphal cell of the conidiophores and are ejected one after the other forming chains. The hyaline micro-conidia are produced more profusely and in chains of from 2 to 75 while the coloured micro-conidia are from 2 to 50 in a chain. Sometimes both forms of micro-conidia occur in the same chain interspersed promiscuously with one another.

Spore germination

Both forms of micro-conidia germinate after 5-8 hours in water or in any moist nutrient media. The germination of both forms of micro-conidia gives rise to the formation of hyaline germ tubes at the ends, a little below the ends or at the middle of the cell. In most cases the germ tubes developed readily into conidiophores producing micro-conidia in chains.

The macro-conidia germinate less readily than the micro-conidia ; usually they germinate after 24 hours. They produce on germination hyaline germ tubes with swollen bases. The germ tubes were found to occur only at the middle of the cell and not to produce conidia immediately as the micro-conidia on germination.

Perpetuation and dissemination

The fungus is a facultative parasite and survives in the soil, on dead roots and crowns, leaf trash or ripe fruits of pineapple. Experiments conducted have shown that the fungus is killed by one hour's exposure to sunlight when grown on solid media but when grown on liquid media several hours' exposure is necessary. Under field conditions the fungus is not usually exposed to direct sunlight and as such it has practically no chance of being killed by being exposed to direct sunlight.

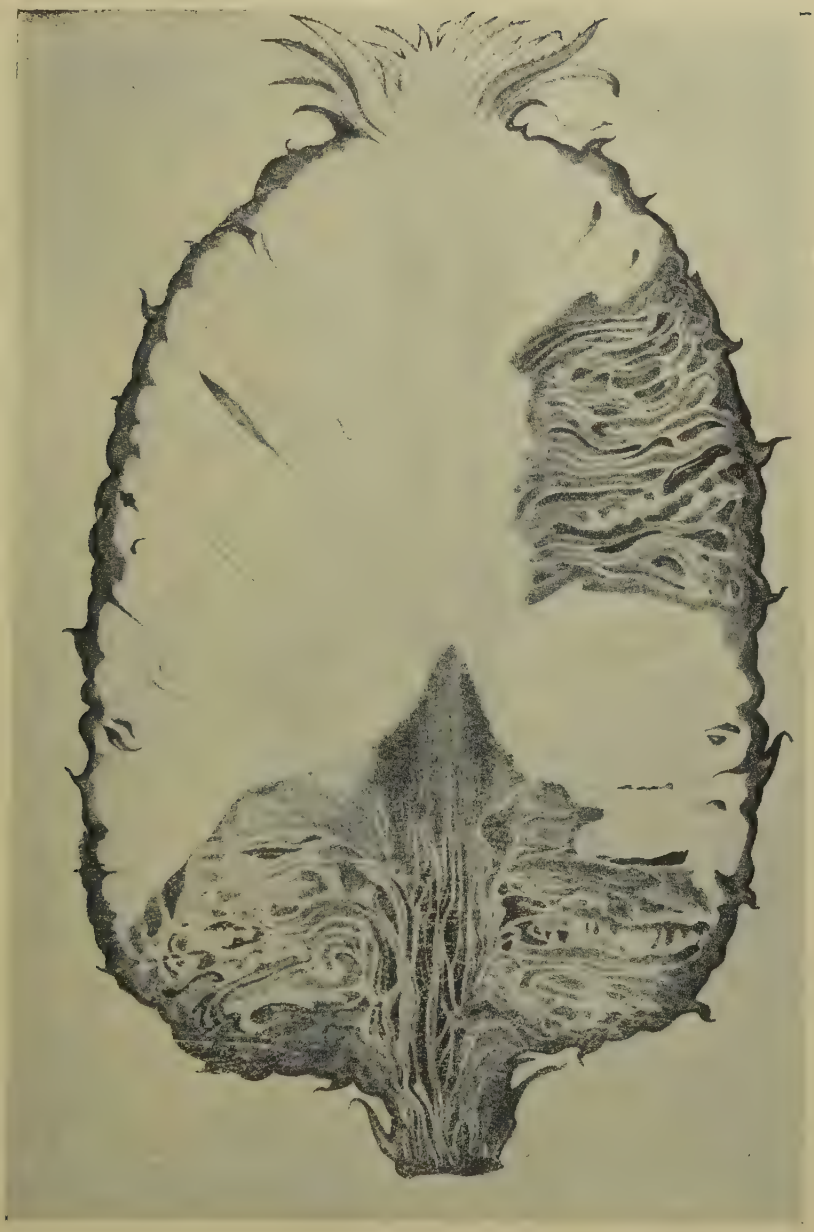
The fungus is disseminated by insects, wind, man and planting material.

Summary

Three diseases of pineapple (*Ananas comosus* = *A. sativus*) due to *Ceratostomella paradoxa* (= *Thielaviopsis paradoxa*) have been noticed throughout the pineapple growing tracts in the Surma Valley and the Hill Districts. These diseases are : leaf-spot, base-rot and fruit-rot.

The symptoms of the diseases are described.

Inoculation experiments were carried out with pure cultures of the fungus and the pathogenecity established. It was found that the fungus could not infect unwounded leaves but both ripe and green fruits were equally susceptible to infection without the aid of wounds.



Symptoms of the disease : *Thielaviopsis* fruit rot of pineapple

Symptoms of the disease : Heart rot of young pineapple plantings— (a) Healthy ; (b) and (c) diseased

The fungus was grown on a large number of dia and its morphology studied.

Methods of spore germination and modes of petuation and dissemination were studied. It s found that the fungus survives in the soil, on d roots and crowns, leaf trash and ripe fruits. e fungus is disseminated by insects, wind, man l through infected planting materials.

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HEART OR STEM-ROT OF PINEAPPLE

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(With Plate V)

ROUGHOUT the pineapple [*Ananas comosus* (L.) rr.] (= *A. sativus* Lindl.) growing tracts of Surma Valley and the Hill Districts, young eapple plants have been found susceptible to estructive disease known as the heart or stem- Diseased plants die with the partial or plete destruction of the meristematic tissue he stem. A careful survey made over the eapple growing tracts during the last four rs has revealed that the distribution of the se in the different fields is highly sporadic, ain fields losing from 7 to 25 per cent of ir plants and others losing none. It has been noticed that the disease develops under np water-logged conditions and is observed ally during the rains.

The disease has not so far been reported from other part of India but it has been found te prevalent in other pine growing countries. ricksen [1905] noted this disease in Puerto o, Larsen [1910] in Hawaii, Ashby [1920] Jamaica, Simmonds [1929] in Australia and rnett [1931] in New South Wales.

Symptoms of the disease

The disease is characterized in the early stages infection by loss of turgidity and a slight sting of the central leaves and in later stages by the withering and discolouration to yellowish pink and brown. In both early and advanced stages the inner whorl of leaves can be readily detached from the stem by a slight pull, the basal tissues of all such leaves having undergone either a partial or complete disintegration. Natural falling of these leaves is a frequent late symptom. The stem may also show either a partial or complete disintegration with a characteristic brownish yellow discolouration at the margins between healthy and diseased tissues. The initial infection may appear at the apical end of the stem, at the base of some leaf, at the basal end of the stem or at the axillary or main roots. The infected tissues soon undergo decomposition. Plate V shows the symptoms of the disease.

Identification of the pathogene and infection experiments

A large number of isolations were made from diseased materials collected from the different pineapple growing tracts. A species of *Phytophthora* was always obtained in culture and all the isolates were found identical.

The morpholgical characteristics of the fungus were studied in culture and were found to agree with the description given for *Phytophthora parasitica* by Dastur [1913]. The fungus is therefore identified to be a strain of *P. parasitica* Dastur.

Infection experiments were carried out by placing bits of pure culture of the fungus at the base of the leaves, on the stem or on the roots of the host. Such infection experiments were repeated many times. Ninety-seven per cent of the inoculations were successful and the plants inoculated developed typical symptoms of the disease. Re-isolations were made and the fungus recovered in all cases. Controls kept remained healthy.

Control measures

For control of heart or stem-rot providing the best drainage and avoiding wounding the planting material appear good precautions. In most cases heart rot attacks weak planting materials which should therefore be avoided. Mehrlich [1931] found that dipping the planting material in a very heavy Bordeaux (one pound copper sulphate crystals ; one pound hydrated lime ; three gallons of water) gave good control. This and a few other concentrations of Bordeaux mixture (2 : 2 : 50, 4 : 4 : 50 and 5 : 5 : 50) were given a wide trial by the author but the concentration suggested by Mehrlich has given the best results.

Summary

Heart or stem-rot of pineapple has been found to be a serious disease in the pineapple growing tracts of the Surma Valley and the Hill Districts.

The symptoms of the disease have been described.

The disease has been found due to *Phytophthora parasitica* Dastur. Pathogenecity has been established by infection experiments.

The disease can be controlled by providing the best drainage, avoiding planting of weak materials and the dipping in of the planting material in a heavy Bordeaux mixture before planting.

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CONTROL OF *CERCOSPORA* BLIGHT OF *TIL*

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Til (*Sesamum orientale* L.) is grown extensively throughout Assam. Agricultural Statistics of Assam for the year 1942-43 report 342,906 acres under this crop in the province. A survey made during the last four years has shown that the only serious disease from which this crop suffers is a blight due to *Cercospora sesami* Zimm. and that this disease causes considerable monetary loss every year. Figures collected show that the yield is reduced 4·5 to 12 per cent due to this disease, in some cases the yield has been reduced even 21 per cent. It may safely be stated that on an average 5 per cent of the yield is reduced every year due to this disease. Taking 5 md. as the average yield of *til* per acre the loss would work out to be 85,741·5 md. per year or Rs. 8,57,410 per annum under the prevailing prices.

As the disease is a serious one a systematic study of the trouble was undertaken in 1940. A paper dealing with the physiology of the causal organism has been published by the author [1944]. In the present paper the methods of perpetuation, dissemination and control of the disease are presented.

Perpetuation of the disease

(i) *Seed transmission.* A large number of seed samples collected from diseased crops were

amined and it was found that the fungus was esent to a maximum extent of 27 per cent ternally in seed samples. Seed saved from seased crops were surface sterilized with 1 : 1000 ercuric chloride solution and then after careful ashing with sterile water plated on oat agar. ne fungus was obtained in culture in 50 per cent the cases. Seeds saved from diseased crops ere sown and diseased crops always obtained. rom these experiments and observations it may concluded that the fungus persists in the seeds. oran and Guba [1928] obtained no evidence at *Cercospora* carotæ was carried on the seed. lotz [1923], Lehman [1934], McKay and Pool 918], Stewart [1910] and Wolf [1916] have cited idence indicating that seed transmission occurs th species of *Cercospora* affecting celery, beets, ll, soybean and peanuts.

(ii) *Persistence in the soil.* Persistence of the ngus in the soil was investigated. Infected *esamum* leaves were collected in July 1941 and aced in wire containers. Some of these were aced on the surface of the soil, some 4 in. and me 6 in. deep. These containers were removed May 1942 and typical *Cercospora* lesions were cured in plants inoculated with water suspensions the decayed leaves. It is evident therefore at the parasite can persist in the plant debris t in the soil. Doran and Guba [1928] have ported that *Cercospora carotae* hibernates in ad leaves of carrots in or on the soil. Klotz 923], Nagel [1938] and Pool and McKay [1916] nd that other parasitic members of this genus er-winter on the dead leaves of their hosts.

From what has been stated above it will appear at the disease can be carried over through fected seeds or infected plant debris lying in the il or both but experiments and observations ade during the last four years have revealed at the disease is principally and primarily carried rough infected seeds.

Dissemination in the field

Observations indicate that wind is the probable ent of dissemination of the disease in the field. ne prevailing wind is from the west and during rvest it has been noticed that the plants along e east side of a field are more severely blighted an those on the west. Sufficient inoculum parently is carried by the wind to increase fection on the east side. Also when there are lds of young *Sesamum* on the east and west sides of a field of older badly infected *Sesamum*, the former in the east field are more heavily infected. Agar plates were exposed for 3 min. at 10, 100 and 300 ft. distant from the leeward side of a field badly affected with *Cercospora* leaf blight. The fungus was recovered from the air at all three locations. Klotz [1923], Pool and McKay [1916], Roldan and Querijero [1939] and Wolf [1916] have reported that wind is an important agent in disseminating the species of *Cercospora* attacking celery, peanuts and beets.

Control measures

Studies so far made have conclusively proved that the disease is principally and primarily carried through infected seeds. Several treatments were therefore applied to *Sesamum* seed to determine those that might be used without seed injury and would be effective in controlling the disease. Mercuric chloride (1 : 1000 for 5 min.) cuprous oxide dust, malachite green, copper sulphate, agrosan and formalin dusts were tried but none were found appreciably effective in controlling the disease. Hot water treatment as suggested by Nusbaum [1941] was therefore tried. Virtually complete control was effected by 30 minutes' immersion of the seed in water heated to 128°F. This was found effective in destroying the inoculum that was borne internally while surface borne inoculum was eliminated by treatment for the same period at 118°F. It was also found that one year's storage freed the seeds from superficial infection but the fungus still persisted in the interior. The practical utility of the hot water treatment was demonstrated on large scale plantings in 1943 and 1944.

Summary

Cercospora blight of *til* (*Sesamum orientale*) due to *Cercospora sesami* is a serious disease in Assam. Figures collected show that the yield is reduced 4·5 to 12 per cent due to this disease ; in some cases it is 21 per cent but the average comes to 5 per cent.

The disease is perpetuated through infected seeds and plant debris lying in the field.

In the field the disease is disseminated by wind.

Seed treatments by chemicals have not been found effective in controlling the disease. Hot water treatment has given very satisfactory results on a field scale.

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THE FUNGI OF BURMA

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The fungus flora of Burma is rich and varied on account of the varied climatic conditions of the country. The first collection of Burmese fungi was made by Kurz, Curator of the Royal Botanic Gardens, Calcutta, about the year 1870 and a further collection was made by E. J. Butler, Imperial Mycologist, about the year 1912. Mycological work in Burma commenced in 1923 and the major portion of this work was devoted to the study of fungi responsible for the diseases of economic plants. During the course of tours, fungi found on wild plants, dead wood and the ground were also collected and added to the herbarium. The commoner fungi were examined and identified at the mycological laboratories at the Agricultural Research Institute, Mandalay, and the others were sent from time to time to the Imperial Mycological Institute, Kew, or the Imperial Mycologist, India, for identification. We are indebted to the various officers of these Institutions for their ready assistance.

At the time of the evacuation of Burma, in April 1942, the mycological herbarium consisted of over 700 specimens and of these about 200 still remained not fully named. Some of these unidentified fungi were no doubt of much systematic interest as some of these could not be placed in any of the known genera. For example, there was a specimen closely agreeing with *Macrophoma* but with the difference that there were clusters of hyaline appendages at each end of the spores.

The list given below does not pretend to be a complete record of all the fungi so far collected in Burma and undoubtedly the collection was very incomplete. The list has been composed partly from personal knowledge but mainly from various publications, the list of which is given. The loss of most of the laboratory records and herbarium material has been a serious hinderance but lest further information disappear this partial list is now published.

We are grateful to Dr B. B. Mundkur of the Imperial Agricultural Research Institute, New Delhi, for various suggestions in the preparation of this paper.

Archimycetes

Spongospora subterranea (Wallr.) Johns.
On tubers of *Solanum tuberosum*, Hsipaw

Phycomycetes

Oomycetes

Allomyces arbusculus Butler
In soil from a pond, Rangoon

Allomyces cystogenus Emerson
In soil from a pond, Rangoon

Allomyces javanicus Kniep
In soil from a pond, Rangoon

Cystopus bliti (Biv.) de Bary
On leaves of *Amaranthus* sp., Moulmein

Cystopus candidus (Pers.) Lév.
On leaves of *Brassica campestris*, Maymyo

Cystopus ipomoeæ-panduratæ (Schw.) Stev. et Swing.
On leaves of *Ipomoeæ reinformis*, Mandalay

Cystopus portulacæ (DC.) Lév.
On leaves of *Portulaca quadrifida*, Bassein

eronospora brassicæ Gäumann
On leaves and fruits of *Brassica campestris*, Amarapura
eronospora effusa (Grev.) Rabenh.
On leaves of *Chenopodium album*, Myingyan
hytophthora colocasiæ Rac.
On leaves, petioles, flowers and corms of *Colocasia antiquorum*, Tavoy ; in roots of *Piper betle*, Madaya
hytophthora infestans (Mont.) de Bary
On leaves of *Lycopersicum esculentum* and *Solanum tuberosum*, Amarapura
hytophthora palmivora Butler
On leaves, twigs, fruits and the tapping cut of *Hevea brasiliensis*, Thaton, Moulmein and Tavoy ; on fruits of Carica papaya, Hmawbi
lasmopara viticola Berk. and Curt.
On leaves of *Vitis vinifera*, Mandalay
seudoperonospora cubensis (Berk. and *Curt.*) Rost.
On leaves of *Lagenaria vulgaris*, Amarapura
ythium aphanidermatum (Edson) Fitz.
On seedlings of *Nicotiana tabacum*, Mandalay ; on rhizomes of *Zingiber officinale*, Moulmein

Zygomycetes

hoanephora cucurbitarum (Berk. and Rav.) Thaxter
On flowers of *Capsicum annuum*, Mandalay
hoanephora infundibulifera (Currey) Cunn.
On flowers of *Hibiscus rosa-sinensis*, Mandalay
hizopus artocarpi Rac.
On fruits of *Artocarpus integer*, Mandalay
hizophus nigricans Ehrenberg
From soil, Mandalay

ASCOMYCETES

Hemiascomycetes

ematospora coryli Peglion
In unripe bolls of *Gossypium neglectum* and *G. hirsutum*, Mandalay ; in young fruits of *Abutilon indicum*, Mandalay. The fungus follows the attack by the red cotton bug, *Dysdercus cingulatus*.
ematospora gossypii Ashby and Nowell
In unripe bolls of *Gossypium neglectum* and *G. hirsutum*, Mandalay ; in young fruits of *Abutilon indicum*, *Hibiscus cannabinus*, *H. panduriformis* and *H. sabdariffa*, Mandalay. The fungus follows the attack by the red cotton bug.
Nematospora sp.
In fruits of *Citrus nobilis*, Hsipaw

Discomycetes

Humaria rutilans (Fr.) Sacc.
On mud banks, Toungoo
Tryblidiella rufula (Spreng.) Sacc.
On dead branches of *Citrus* sp. and *Psidium guajava*, Sagaing and Mandalay
Tuber indicum Cke and Massee
In the earth, Mandalay

Pyrenomycetes

Apiospora camptospora Penzig and Sacc.
On leaf-sheaths of *Saccharum officinarum*, Bilin
Asterina lawsoniæ P. Henn et Nym.
On leaves of *Lawsonia alba*, Gyobingauk
Asterina magnifica Syd. et Butl.
On leaves of *Terminalia* sp., Moulmein
Balansia andropogonis Syd.
On inflorescence of *Chrysopogon aciculatus*, Mandalay and Pa-an
Capnodium sp.
On leaves of *Eryobotrya japonica*, Maymyo ; on leaves of *Gossypium* spp. and *Mangifera indica*, Mandalay ; on leaves of *Saccharum officinarum*, Pyinmanna
Catacauma acaciæ Thiess. et Syd.
On leaves of *Acacia leucophloea*, Mandalay
Catacauma infectorium (Cke.) Thiess. et Syd.
On leaves of *Ficus religiosa*, Insein and Mandalay
Ceratostomella paradoxa (de Seynes) Dade
In fruits of *Ananas sativa*, Maymyo ; on fruits of *Areca catechu*, Madaya ; on trunk of *Borassus flabellifer*, Mandalay
Claviceps sp.
In ovaries of *Sorghum dochna*, Mandalay and Thaton
Clematomyces pinophili Thaxt.
On the inferior surface of *Pinophilus* sp., Pegu
Daldinia concentrica (Bolt.) Ces. et de Not.
On dead wood of *Aleurites montana*, Hsipaw
Diplocarpon rosæ Wolf
On leaves of *Rosa* spp., Maymyo
Endodothella bambusæ (Rabenh.) Thiess and Syd.
On leaves of *Bambusa* sp., Moulmein
Erysiphe cichoracearum DC.
On leaves of *Cucurbita ovifera*, Maymyo

Erysiphe polygoni DC.
On leaves and inflorescence of *Coriandrum sativum*, Mandalay
Glomerella gossypii (South.) Edg.
On bolls of *Gossypium* sp., Amherst
Hypocrella discoidea (Berk. and Br.) Sacc.
On *Aleyrodes* on Tectona *grandis*, Rangoon
Hypocrella mollii Koorders
On *Aleyrodes on Tectona grandis*, Rangoon; on *Aleyrodes* on *Castanopsis* sp., Shan States
Hypoxylon marginatum (Schw.) Berk.
On wood, Toungoo
Laboulbenia euschizomeri Speg.
On *Euschizomerus æneus*, Tikelæ
Laboulbenia crechtochili Thaxt.
On the margin of elytrae of *Orechtochilus typus*, Tenasserim
Laboulbenia crechtochilicola Speg.
On *Orechtochilus feae*, Tenasserim
Leptosphaeria sacchari Breda de Haan
On leaves of *Saccharum officinarum*, Pyinmanna and Bilin
Massarina usambarensis (P. Henn.) v. Hoehn.
On the bark of *Citrus aurantium*, Moulmein
Meliola bicornis Wint.
On leaves on *Desmodium* sp., Basein
Meliola butleri Syd.
On leaves of *Citrus decumana*, Kya-in
Meliola cladotricha Lév.
On coriaceous leaves of an unknown host, Kya-in
Meliola jasminicola P. Henn.
On leaves of *Jasminum* sp., Gyobingauk
Meliola mangiferæ Earle
On leaves of *Mangifera indica*, Insein
Meliola pterospermi Stev.
On leaves of *Pterospermum* sp., Lower Burma
Metasphaeria albescens Thuem.
On leaves of *Oryza sativa*, Hmawbi and Tavoy
Nectria bolbophylli P. Henn.
On grains of *Oryza sativa*, Hmawbi
Nectria diploa Berk. and Curt.
On a scale insect on *Indigofera*, Bassein
Nectria diversispora Petch
On fruits of *Hevea brasiliensis*, Mergui and Moulmein
Nectria eugniæ Currey
On dead leaves of *Eugenia* sp., Yomah
Nectria heterosperma Kalchbr. and Cke
On branches of *Citrus aurantium*, Sagaing
Neocosmospora vasinfecta Smith
On roots of *Cicer arietinum*, Padu
Peroneutypella pusilla Syd.
On dead branches of *Citrus* sp., Sagaing
Phragmocapnias betle (Syd. et Butl.) Thiess. et Syd.
On leaves of *Piper betle*, Mudon
Phyllachora assimilis Syd.
On leaves of *Capillipedium parviflorum*, Maymyo
Phyllachora centothecæ Syd.
On leaves of *Centotheca lappacea*, Moulmein
Phyllachora cynodontis (Sacc.) Niessl
On leaves of *Cynodon dactylon*, Mandalay
Phyllachora dalbergiæ Niessl
On leaves of *Dalbergia lanceolata*, Bassein
Phyllachora graminis (Pers.) Fckl.
On leaves of *Pollinia grata* (= *Microstegium gratum*), Moulmein
Phyllachora ischaemi Syd.
On leaves of *Schima nervosum*, Bilin
Phyllachora permixta Syd.
On leaves of *Schima wallichii*, Maymyo
Phyllachora rhytismoides (Cda.) Sacc.
On leaves of *Mimosa* sp., Tenasserim
Phyllachora Sacchari P. Henn.
On leaves of *Saccharum officinarum*, Pyinmanna
Phyllachora sacchari-spontanei Syd.
On leaves of *Saccharum spontaneum*, Bassein
Phyllachora sorghi v. Hoehn.
On leaves of *Sorghum dochna* and *S. roxburghii*, Tatkon
Phyllactinia corylea (Pers.) Karst.
On leaves of *Morus* sp., Mandalay and Maymyo
Physalospora transversalis Syd.
On living leaves of *Cocos nucifera*, Bilin
Pleosphæropsis dalbergiæ Died.
On leaves of *Dalbergia sissoo*, Kyaukse
Pyrenocarpon magnificum (Syd. et Butl.) Theiss.
On leaves of *Terminalia* sp., Moulmein
Rosellinia sublimbata (Durieu and Mont.) Pass.
On stems of *Thysanolæna procera*, Kanbalataung
Sirrhodothis seriata Syd. and Butler
On leaves of *Bambusa* sp., Moulmein
Sphaerostilbe repens Berk. and Br.
On roots of *Hevea brasiliensis*, Moulmein
Sphaerotheca humuli var. fuliginea (Schlecht.) Salm.
On leaves of *Phaseolus aconitifolius*, Mandalay

cinula tectonæ Salmon
On leaves of *Tectona grandis*, Lower Burma
tilaginoidea ochracea P. Henn.
In the flowers of *Panicum auritum*, Hmawbi
tilaginoidea virens (Cke.) Tak.
In the flowers of *Oryza sativa*, Mandalay, Hmawbi, etc.
tulina zonata (Lév.) Sacc.
On trunk of *Hevea brasiliensis*, Moulmein and Tavoy
laria guyanensis Mont.
In ever-green forests, Toungoo
laria hypoxylon (L.) Grev.
On old tree stumps, Arrakan
laria nigripes (Klotzsch) Sacc.
On the ground and on termites nests, Mandalay

Basidiomycetes

Ustilaginales

ractia axicola (Berk.) Cornu
In the peduncles of *Fimbristylis dichotoma*, Mandalay
yloma eugeniarum Cke. and Massee [Petrak and Sydow (Ann. Mycol. 23 : 261, 1925) state this is not a smut]
On leaves of *Eugenia ? tetragona*, Maymyo
yloma oryzæ Syd.
On leaves of *Oryza sativa*, Hmawbi
phiola borassi Syd. and Butler
On leaves of *Borassus flabellifer*, Kyaukse
phiola phoenicis (Moug.) Poiteau
On leaves of *Phoenix* sp., Mandalay
ovossia horrida (Tak.) Padwick and Azmat.
In ovaries of *Oryza sativa*, Mandalay and Hmawbi
osporium furcatum Syd. and Butler
In ovaries of *Ischaemum aristatum*, Insein
acelotheca andropogonis-annulati (Bref.) Zundel.
In ovaries of *Dichanthium annulatum*, Mandalay
acelotheca reiliana (Kuehn) Clinton
In inflorescence of *Sorghum dochna* and *S. roxburghii*, Tatkon
acelotheca sorghi (Link) Clinton
In ovaries of *Sorghum dochna* and *S. roxburghii*, Mandalay
ilago burmanica Syd. and Butler
In ovaries of *Ischæmum* sp., Kya-in
Ustilago cynodontis P. Henn.
In inflorescence of *Cynodon dactylon*, Mandalay
Ustilago kolleri Wille
In ovaries of *Avena sativa*, Taunggyi
Ustilago scitaminea Syd.
In culms and terminal shoots of *Saccharum officinarum*, Pyinmanna
Ustilago tritici (Pers.) Rostr.
In ovaries of *Triticum æstivum*, throughout Upper Burma
Ustilago utriculosa (Nees.) Tul.
In ovaries of *Polygonum tomentosum*, Rangoon

Uredinales

Aecidium mori Barclay
On leaves of *Morus alba*, Maymyo
Aecidium spissum Syd.
On leaves of *Zanthoxylum* sp., Maymyo
Cerotelium desmium (Berk. and Br.) Arth.
On leaves of *Gossypium* sp., Allanmyo
Cerotelium fici (Cast.) Arth.
On leaves of *Ficus carica*, Mandalay; on leaves of *F. palmata*, Mandalay and Maymyo
Hapalophragmium ponderosum Syd. and Butler
On twigs of *Acacia leucophloea*, Mandalay
Hemileia vastatrix Berk. and Br.
On leaves of *Coffea arabica*, Leiktho
Masseeella fluggeæ Syd.
On leaves of *Fluggea microcarpa*, Padu
Phakopsora phyllanthi Diet.
On leaves of *Phyllanthus disticus*, Mandalay
Phakopsora zizyphi-vulgaris (P. Henn) Diet.
On leaves of *Zizyphus jujuba*, Mandalay
Phragmidium burmanicum Syd.
On leaves of *Rubus lasiocarpus*, Maymyo
Sydow transfers this to the new genus *Phragmotelium*.
Puccinia arundinellæ Barclay
On leaves of *Arundinella* sp., Maymyo
Puccinia burmanica Syd. and Butler
On leaves of *Anthistrria imberbis* (=Themeda *triandra*), Maymyo
Puccinia butleri Syd.
On leaves and stalks of *Launæa asplenifolia* Amarapura
Puccinia glumarum (Schm.) Erikss. and Henn.
On leaves, culms and glumes of *Triticum æstivum*, Mandalay
Puccinia graminis Pers.
On leaves, culms and glumes of *Triticum æstivum* and *Hordeum vulgare*, Mandalay

Puccinia inayati Syd.
On leaves of *Launœa nudicaulis*, Lower Burma
Puccinia kozukensis Diet.
On leaves of *Andropogon micranthus* (= *Capillipedium parviflorum*), Maymyo
Puccinia kuehnii (Krueg.) Butler
On leaves of *Saccharum spontaneum*, Bassein
Puccinia prainiana Barclay
On leaves of *Smilax* sp., Bilin
Puccinia purpurea Cke
On leaves of *Sorghum dochna* and *S. roxburghii*, Mandalay; on leaves of *Sorghum halepene*, Mandalay
Puccinia romagnoliana Maire and Sacc.
On leaves of *Cyperus* sp., Hmawbi
Puccinia rufipes Diet.
On leaves of *Imperata cylindrica*, Moulmein
Puccinia solmsii P. Henn.
On leaves of *Polygonum* sp., Maymyo
Puccinia sorghi Schw.
On leaves of *Zea mays*, Amarapura
Puccinia thwaitesii Berk.
On leaves of *Justicia gendarussa*, throughout Burma
Puccinia triticina Erikss.
On leaves of *Triticum æstivum*, throughout Upper Burma
Puccinia versicolor Diet and Holw.
On leaves of *Heteropogon contortus*, Maymyo
Pucciniastrum castaneæ Diet.
On leaves of *Castanopsis javanica*, Maymyo
Ravenelia emblicæ Syd.
On leaves of *Phyllanthus emblica*, Maymyo
Sphœrophragmium acaciæ (Cke.) P. Magn.
On leaves of *Albizzia lebbeck*, Myitnge
Tranzschelia pruni-spinosæ (Pers.) Arthur
On leaves of *Prunus armeniaca* and *P. persica*, Maymyo
Uredo cajani Syd.
On leaves of *Cajanus cajan*, Tatkon
Uredo fuirenæ P. Henn.
On leaves of *Fuirena glomerata*, Bassein
Uredo tectonæ Racib.
On leaves of *Tectona grandis*, Madaya
Uromyces appendiculatus (Pers.) Link
On leaves of *Dolichos lablab* and *Vigna unguiculata*, Amarapura
Uromyces commelinæ Cke
On leaves of *Commelina bengalensis*, Mandalay
Uromyces decoratus Syd.
On leaves and stem of *Crotalaria juncea*, Amarapura
Uromyces fabæ (Pers.) de Bary
On leaves of *Pisum arvense* and *P. sativum*, Maymyo
Uromyces linearis Berk and Br.
On leaves of *Panicum repens*, Mandalay
Uromyces mucunæ Rabenh.
On leaves of *Mucuna* sp., Maymyo

Hymenomycetes

Amanitopsis sp.
On the ground, Kanbalu
Auricularia mesenterica Fr.
On decaying wood, Mandalay
Collybia albuminosa (Berk.) Petch
On termites nests, Tonbo
Coprinus spp.
On dung and paddy straw heaps, Mandalay
Corticum salmonicolar Berk. and Br.
On branches of *Hevea brasiliensis*, Mergui and Thaton; on branches of *Cinchona* sp., Mergui
Corticum spp.
On branches of *Aleurites montana*, Hsum-Hsai; on decomposing paddy straw, Mandalay
Dædalea discolor Fr.
On the ground, Pegu Yoma
Daedalea tenuis Berk.
On dead wood, Pegu Yoma
Daedalea unicolar (Bull.) Fr.
On stumps, Pegu
Daedalea zonata Schwein.
On dead wood, Toungoo
Entoloma microcarpum Berk. and Br.
On termites nests, Tonbo
Exobasidium vexans Massee
On leaves of *Camellia sinensis*, Toungoo Hills
Fomes holosclerus Berk.
On dead wood, Pegu Yoma
Fomes lamaoensis (Murr.) Sacc. and Trott.
On roots of *Broussonetia papyrifera* and *Hevea brasiliensis*, Thaton
Fomes marginatus Fr.
On dead trees, Toungoo Hills
Fomes pseudoferreus Wakefield
On roots of *Hevea brasiliensis*, Moulmein
Galera zeylanica Petch
On the ground, Mandalay
Ganoderma applanatum (Pers.) Pat.
On tree trunks, Toungoo

noderma lucidum (Leyss.) Karst.
On trunk of *Areca catechu*, Madaya, causing the stem-bleeding disease; on *Morus* sp., Maymyo
epinia spathularia (Schw.) Fr.
On old logs, Mandalay
xagonia similis Berk.
On dead wood of *Mangifera indica*, Mandalay
rneola auricula-judæ (L.) Berk.
On dead wood and fallen branches, Kanbalu
rneola nigra (Swartz) Fr.
On logs, North Yoma
ex pallescens Fr.
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tinus capronatus Fr.
On dead wood, Myodwine
tinus curreyanus Sacc. and Cub.
On dead wood, Lower Burma
tinus descendens Fr.
On dead wood, Toungoo
tinus polychrous Lév.
On dead wood, Yoma Range
tinus velutinus Fr.
On dead wood, Pegu Yoma
tinus sp.
On dead shoots of *Bambusa* sp., Mandalay
Edible
zites albida Fr.
On dead wood, Toungoo
zites repanda (Mont.) Fr.
On dead tree trunks, Toungoo
iota sp.
On the ground amongst grass, Mandalay. Edible
rasmius burmensis Cke.
On twigs, Moulmein
rasmius sacchari Wakker
On exotic varieties of *Saccharum officinarum*, Mandalay
ucoria sp.
On the ground, Mandalay
aeolus cyanescens Berk. and Br.
On cowdung heaps, Mandalay. Poisonous
us sp.
On dead wood, Mandalay. Edible
yporus bicolor Jungh.
On wood, Toungoo
yporus rhodophaeus Lév.
On dead wood, Toungoo
ystictus cinerescens Schwein.
On wood, Pegu Yoma
Polystictus flabelliformis Klotzsch.
On dead wood, Yoma Range
Polystictus modestus Kunze
On dead wood, Yoma Range
Psathyrella sp.
On the ground, Mandalay
Schizophyllum commune Fr.
On dry fruits of *Garcinia mangostana*, Mudon, and on dead wood throughout Burma
Stereum adustum Lév.
On wood, Southern Yoma
Stereum elegans Meyer
On wood, Lower Burma
Stereum lobatum Fr.
On dead wood, Toungoo
Stereum princeps Jungh.
On dead wood, Toungoo Hills
Trametes cingulata Berk.
On dead wood, Pegu Yoma
Tremella sp.
On dead wood, Mandalay
Volvaria diplasia Berk. and Br.
On rotten paddy-straw heaps, all over Burma. Edible

Gasteromycetes

Bovista brasiliensis (Fr.) de Toni
On the grounp, Toungoo
Dictyophora ? indusiata (Ventenat) Pers.
On ground in rubber estate, Moulmein
Geaster sp.
On the ground, Kanbalu. Edible
Ithyphallus impudicus (L.) Fr.
On the ground, Mandalay
Lycoperdon sp.
On the ground, Madaya
Podaxon pistillaris (L.) Fr.
On rich sandy soils, Madaya. Edible

Fungi imperfecti

Hyphomycetes (and *Mycelia sterilia*)

Actinonema rosæ (Lib.) Fr.
On leaves of *Rosa* sp., Maymyo
Alternaria brassicæ (Berk.) Sacc.
On leaves of *Brassica campestris*, Amarapura
Alternaria circinans (Berk. and Curt.) Bolle
On leaves of *Brassica oleracea*, Mandalay
Alternaria solani (Ell. and Mart.) Jones and Grout
On leaves of *Solanum tuberosum*, Amarapura

Aspergillus flavus Link
In isolations from paddy soil, Mandalay
Aspergillus fumigatus Fresenius
On match sticks, Mandalay
Aspergillus niger van Tieghem
In isolations from paddy soil, Mandalay; on scales of *Allium* sp., Mandalay
Aspergillus tamarii Kita
In isolations from paddy soil, Mandalay
Aspergillus terreus Thom
In isolations from paddy soil, Mandalay
Cercospora coffeicola Berk. and Cke
On leaves of *Coffea arabica*, Leiktho
Cercospora dolichi Ell. and Ev.
On leaves of *Dolichos lablab*, Amarapura
Cercospora feuilleauboisii Sacc.
On leaves of *Solanum melongena*, Mandalay
Cercospora henningsii Allesch.
On leaves of *Manihot utilissima*, Mudon
Cercospora Hibisci Tracy and Earle
On leaves of *Hibiscus sabdariffa* and *H. cannabinus*, Mandalay
Cercospora kopkei Krug.
On leaves of *Saccharum officinarum*, Sahmaw
Cercospora menispermi Ell. and Holw.
On leaves of *Cocculus vilosus*, Mandalay
Cercospora neriella Sacc.
On leaves of *Nerium odorum*, Mandalay
Cercospora nicotianæ Ell. and Ev.
On leaves of *Nicotiana tabacum*, Amarapura
Cercospora oryzæ Miyake
On leaves of *Oryza sativa*, all over Burma
Cercospora patouillardi Sacc. and D. Sacc.
On leaves of *Calotropis gigantea*, Mandalay
Cercospora personata (Berk. and Curt). Ell. and E.
On leaves of *Arachis hypogaea*, all over Burma
Cercospora sesami Zimm.
On leaves of *Sesamum orientale*, Tatkon
Cercospora sorghi Ell. and Ev.
On leaves of *Sorghum dochna* and *S. roxburghii* Mandalay
Cercospora traversiana Sacc.
On leaves of *Trigonella fœnu-graecum*, Mandalay
Cercospora viticola (Ces.) Sacc.
On leaves of *Vitis vinifera*, Insein
Cercospora sp.
On leaves of *Mimosa pudica*, Hmawbi
Cerebella andropogonis-contorti Subram.
On ovaries of *Heteropogon contortus*, Maymyo
This and other species of *Cerebella* grow upon forms of *Sphacelia* on the various hosts
Cerebella burmanensis Subram.
On ovaries of *Brachiaria setigera*, Mandalay
Cerebella cynodontis Syd.
On ovaries of *Cynodon dactylon* and *Brachiaria reptans*, Mandalay
Cerebella inquinans (Berk. and Br.) Petch
On ovaries of *paspalum scrobiculatum*, Bassein and Hmawbi
Cerebella volkensii (P. Henn.) Mundkur
On ovaries of *Sorghum dochna*, all over Upper Burma
Cladosporium herbarum (Pers.) Link
On grains of *Triticum aestivum*, Mandalay; on capsules of *Sesamum orientale*, Tatkon
Cladosporium zizyphi Karst. and Roum.
On leaves of *Zizyphus jujuba*, Mandalay
Coniosporium bambusæ (Thum. and Bolle) Sacc.
On culms of *Bambusa* sp., Insein
Curvularia lunata (Wakker) Boedijn
In isolations from paddy soil, Mandalay; on flowers of *Dichanthium, annulatum*, Mandalay
Exosporium palmivorum Sacc.
On leaves of *Borassus flabellifer*, Moulmein
Fusarium moniliforme Sheld.
Causing top-rot disease of *Saccharum officinarum*, Pyinmanna
Fusarium udum Butler
On roots and stem of *Cajanus cajan*, Tatkon
Fusarium vasinfectum Atk.
On roots of *Gossypium neglectum*, Mahlaing
Fusarium sp.
On stem and capsules of *Sesamum orientale*, all over Burma
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Helminthosporium gramineum Rabenh.
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idium erysiphoides Fries
On *Pisum sativum*, Maymyo ; on *Sesamum orientale*, Tatkon, on *Lagenaria vulgaris*, Amarapura ; on *Vigna unguiculata*, Amarapura ; on leaves and pods of *Cajanus cajan*, Taunggyi ; on *Cucurbita* spp., Amarapura

idium mangiferæ Berthet
On inflorescence of *Mangifera indica*, Mandalay

enicillium digitatum Sacc.
On fruits of *Citrus aurantium*, Mandalay

enicillium italicum Wehm.
On fruits of *Citrus aurantium*, Mandalay

iricularia grisea (Cke.) Sacc.
On leaves of *Digitaria pruriens*, Amarapura

iricularia oryzæ Cavara
On leaves of *Oryza sativa*, throughout Burma

umularia areola Atkinson
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phacelia sorghi McRæ
On inflorescence of *Sorghum dochna*, Mandalay and Tatkon

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Puccinia kuehnii
Schima nervosum Thw.
Phyllachora ischæmi
Schima wallichii Chois.
Phyllachora permixta
Sesamum orientale L.
Cercospora sesami
Cladosporium herbarum
Fusarium sp.
Helminthosporium sp.
Oidium erysiphoides
Macrophomina phaseoli
Smilax sp.
Puccinia prainiana
Solanum melongena L.
Cercospora feuilleauboisii
Oidiopsis taurica
Solanum tuberosum L.
Alternaria solani
Phytophthora infestans
Rhizoctonia solani
Sclerotium rolfsii
Spongospora subterranea
Sorghum halepense Pers.
Puccinia purpurea
Sorghum spp.
Cerebella volkensii
Cercospora sorghi
Claviceps sp.
Collectotrichum graminicolum
Phyllachora sorghi
Puccinia purpurea
Sphacelotheca reiliana
Sphacelotheca sorghi
Sterculia alata Roxb.
Glœosporium sp.
Tectona grandis L. f.
Aschersonia cinnabarina
Hypocrella discoidea
Hypocrella mollii
Phyllosticta tectonæ
Uncinula tectonæ
Uredo tectonæ
Terminalia catappa L.
Glœosporium terminaliæ
Phyllosticta catappæ
Terminalia sp.
Asterina magnifica
Pyrenocarpon magnificum
Themeda (*Anthistiria*) *triandra* Forsk.
Puccinia burmanica
Themeda sp.
Collectotrichum sp.
Thysanolæna procera Mez.
Rosellinia sublimbata
Trigonella fœnum-graceum L.
Cercospora traversiana
Triticum æstivum L.
Cladosporium herbarum
Helminthosporium sativum
Puccinia glumarum
Puccinia graminis
Puccinia triticina
Sclerotium rolfsii
Ustilago tritici
Tropæolum majus L.
Oidiæopsis taurica
Vigna unguiculata (L.) Walp.
Oidium erysiphoides
Uromyces appendiculatus
Vitis vinifera L.
Cercospora viticola
Plasmopara viticola
Zanthoxylum sp.
Aecidium spissum
Zea mays L.
Diplodia sp.
Helminthosporium turcicum
Puccinia sorghi
Zingiber officinale Rosc.
Pythium aphanidermatum

Zizyphus jujuba Lamk.
Cladosporium zizyphi
Phakopsora zizyphivulgaris

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INDIAN PLANTS LIABLE TO PRODUCE DERMATITIS

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There are a number of plants which are capable of producing irritation of the skin. This may be brought about by contact with the skin as in the case of some species belonging to the genera *Rhus*, *Holigarna*, *Urtica*, etc. resulting in minor or temporary irritation of the skin or painful irritation and inflammation with vesicles or blisters, depending on the severity of the contact and the susceptibility of the individual. Further, there are certain plants, such as *Fagopyrum esculentum*, Moench., *Hypericum perforatum*, Linn. etc. which if ingested by certain livestock under certain conditions lead to a photosensitization and consequent dermatitis of the unpigmented portions of the skin. Dermatitis may, therefore, be either produced by contact with irritant substances produced by the plant or by ingestion of the plant itself. An important point to remember in the case of these plants is that a number of them produce dermatitis only occasionally in individuals who are especially susceptible to them. Others are more troublesome and cause dermatitis in many, but not all, individuals who may come in contact with them or eat them.

The spines and thorns of a number of plants are also capable of entering the skin and setting up irritation. In some cases when the punctures so formed in the skin become subsequently infected with harmful micro-organisms serious septic wounds may be produced. Such plants are found in abundance in India, but obviously the injury they inflict is mechanical and hence they cannot come under the category of poisonous plants. They are, therefore, excluded from the scope of the present paper. On the other hand, the hair on the pods of some species of *Mucuna* have more or less a mechanical action in producing irritation; these have been included in this paper. The reason is that unlike the sharp spines which produce merely mechanical injury they produce prolonged irritation and itching due possibly to the presence of certain chemical substances. It has been considered desirable, therefore, to draw attention to the existence of such plants the irritation produced by which very closely resembles that produced by stinging nettles.

In India approximately 76 plants occur which are capable of producing dermatitis in susceptible individuals. In some cases their action is explicable by the presence of irritant substances produced by the plants, in other cases the phenomenon is not yet fully understood. The following are some of the important types of plants which may injure the skin and which are usually met with in this country:

(1) Rhus *type where the juice of plant comes in contact with the skin and produces dermatitis:* Sollmann [1936] writing about some of the foreign species of *Rhus* says "Contact with certain species of *Rhus* common along roadsides, on fences, in woods and swamps, etc., produces typical dermatitis passing through the successive stages of hyperemia and itching, to voilent vesication, edema, and suppuration, according to the specific sensibility of the individual; many persons are practically immune, although a sufficient quantity of the isolated toxicodendrol has never failed to produce dermatitis.

The active ingredient of all the species is a phenolic oily resin, toxicodendrol, contained in the sticky sap of the plants, which exudes when the plant is injured. It is identical or very similar in all the toxic *Rhus* species. It is so highly active that 1/1,000 mg. has caused severe vesication. Toxicodendrol is not volatile, but it may be conveyed to some distance in the soot in the smoke of burning plants, and perhaps on dust, and by insects alighting on injured plants. None is

present in the pollen, as has been claimed. It may be conveyed by the hands or clothing from one person to another, as if it were contagious." Travellers in the Himalayan forests often hear some of the villagers having almost similar belief regarding the Indian species of *Rhus*. They would not touch the *rhus* trees or have anything to do with them; some of them actually avoid even passing under them. Even the smoke, smell or sight, they say, will cause swelling and vesication of the skin. And yet it has been observed that many individuals are immune to these plants. To a lesser extent species of *Holigarna* are similarly dreaded in India. Such cases of poisoning may be treated thus: After contact the exposed part may be freely washed with some alkaline solution. A 5 per cent solution of ferric chloride or ordinary soap solution are best used for the purpose. Before exposure, use of this measure may prevent the manifestation of harmful effects. Local application of baking soda or Epsom salts, one or two teaspoonful to a cup of water, or a 5 per cent solution of potassium permanganate may relieve the pain caused by inflammation. Fluid extracts of Grindelia, diluted with 6 to 10 parts of water is recommended for preventing the spread of inflammation. Ointments containing fatty or oily substances should not be used as the poison is soluble in oils and will, therefore, spread over other parts. Such emollients may, however, be applied as soothing agents, after the poison has been thoroughly washed away. It has been found by experiment that a certain amount of tolerance to the toxic effects of this plant may be developed in man by giving *per os* small and increasing doses of an alcoholic extract made from the plant to susceptible individual. Attacks of dermatitis in man caused by these plants may be prevented by subcutaneous injection of the alcoholic extract. The immunity produced by this method, however, does not persist longer than one month [Schamberg, 1919].

Important families which include plants whose juices are harmful are Anacardiaceae, Asclepiadaceae, Araceae and Euphorbiaceae. Species of *Semecarpus*, *Rhus*, *Holigarna*, *Excoecaria*, *Euphorbia*, *Calotropis*, *Arisaema*, etc. are the well-known examples in the point.

(2) *Urtica type where apparently the stiff hairs on the plant are responsible for producing dermatitis:* Urticaria produced by contact with the hairs on the stinging nettles, such as species of *Urtica*, *Girardinia*, *Laportea*, *Fleurya*, *Tragia*, etc. is well known. This urticaria is an inflammatory disorder accompanied by a considerable burning and itching in the affected part. The rash may come out in large or small patches, remaining for a few minutes or several hours and may disappear quite abruptly. It usually leaves no trace behind. *Laportea crenulata* Gaud. is perhaps the worst of all stinging nettles found in India. Contact with its hairs produces severe burning pain which may last for several days and is said to be greatly aggravated by the application of water. The sting is particularly powerful during the flowering season when it is said to bring on voilent sneezing, sleeplessness and fever, hence the local English names (Fever nettle, Devil nettle) by which the plant is known to coffee planters. According to Haines [1921-25] the plant is quite innocuous at some times of the year. This may be so on account of the hairs being deciduous, and that they are especially abundant on the inflorescence, but we have never found the plant to be entirely harmless at any time. Haines remarks that while cutting coupe-lines in November in the Sikkim Tarai, where it is sometimes gregarious, his coolies were attacked with sneezing, violent catarrh and ultimately vertigo, apparently from inhaling the numerous minute hairs. Out of all these stinging nettles the mechanism of producing dermatitis in the case of *Urtica dioica* Linn. is well understood, and it is likely that others may resemble this plant to a greater or less degree. What happens in the case of *Urtica dioica* is that the very fragile ends of the hair penetrate the skin and are broken off. The irritating principle from inside the hair is brought in contact with the tissues and the uncomfortable itchy sensation accompanied by nettle rash supervenes. It has generally been accepted that the irritating material in the stinging hairs of this plant is formic acid, but investigation by Cleery [1927] has thrown a considerable light on the subject. According to this author the protoplasm of these hairs has an alkaline reaction, and encloses an acid cell sap. The cell sap contains a small amount of formic acid as well as acetic, butyric, and other volatile fatty acids. The specific poison of the cells, which is a non-volatile substance of an acid nature allied to the resin acids, is in solution in these acids. It is neither formic acid, nor probably an enzyme, or a toxalbumin.

According to Cleery [1927] it is without doubt allied to the irritant substances found in some Primulaceae, Anacardiaceae and allied plants.

A popular remedy against the stings of these stinging nettles is to rub over the affected part the leaves of *Rumex nepalensis* Spreng. and *R. orientalis* Bernh. which are commonly met with and are often found near the nettles. They afford substantial relief, but if these are not available one's own saliva rubbed in is quite effective. Dilute ammonia is a good remedy and if available should be rubbed in over the affected parts.

(3) *Photosensitization caused by the ingestion of plants :* Some plants, such as *Fagopyrum esculentum* Moench. and *Hypericum perforatum* Linn., if ingested under certain conditions and stages of growth are capable of producing photosensitization and consequent dermatitis of unpigmented portions of the skin. All kinds of stock and laboratory animals which have an unpigmented skin and which are exposed to sunlight after the ingestion of the plant are liable to get this condition. Animals having pigmented skins or those not exposed to bright sunlight do not develop any symptoms. Photosensitization can be prevented by (*a*) feeding these plants to stabled animals only and discontinuing the feeding about a month before animals are sent out to graze ; (*b*) allowing such animals to graze in the early morning, late afternoon and at night only ; and (*c*) by covering or staining albinos and white parts of pigmented animals. When the animal is actually affected, feeding must be discontinued at once. The animal must be immediately shaded and a purgative given. Symptomatic treatment should also be applied. Among human beings, certain individuals are known to be sensitive to buckwheat which comes under this category. Severe itching is experienced and a rash is produced after eating food made from buckwheat flour.

(4) *Miscellaneous :* Some plants, such as *Xanthium strumarium* Linn., produce dermatitis only in very few individuals who are sensitive to this plant and that too only at the pre-fruiting stage. This has been observed in the case of our own plant collector who has often suffered by contact with this plant. The poisonous principle responsible for this action is not known. In other cases, such as in *Lasiosiphon eriocephalus* Decne., contact with the plant under natural conditions does not usually produce dermatitis. The dust from dried plants produces smarting of the eyes and mucous membranes and even of the intact skin.

Essential oils contained in the plants are sometimes responsible for irritating the skin, such as in the case of *Erigeron canadensis* Linn. and *Ruta graveolens* Linn. The resin from the root-stocks of *Podophyllum hexandrum* Royle is capable of producing severe irritation of the eyes and the mucous membranes generally. There are in addition a number of plants the exact mechanism of whose action or the active principles responsible for producing dermatitis are not yet fully understood. Research could be profitably undertaken on these plants so that rational treatments may be evolved against their injurious effects.

Below is given a list of plants occurring in India, which have been responsible for producing dermatitis. Their English names, common vernacular names, distribution, part or parts responsible for this condition and their chemical constituents and other general information, so far as these are known, are indicated for each species.

We are grateful to Col. Sir Ram Nath Chopra, C.I.E., for the valuable help and advice he has given us.

The following are the abbreviations used for the vernacular names :

Be.—Bengali ; *Bo.*—Bombay ; *Hi.*—Hindi ; *Kash.*—Kashmir ; *Kum.*—Kumaon ; *Ladd.*—Laddakh ; *Lep.*—Lepcha ; *Mal.*—Malayalam ; *Mar.*—Marathi ; *Nep.*—Nepali ; *Pers.*—Persian ; *Pun.*—Punjabi ; *Sans.*—Sanskrit ; *Tam.*—Tamil ; *Tel.*—Telugu.

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
1. *Abroma augusta* Linn. *f.* English— Devil's Cotton Vernacular— Hi. & Be.—*Ulatkambal;* Bo.—*Ulaktambal*	A shrub, native or cultivated, throughout the hotter parts of India from the North-West India to Sikkim at alt. of 3,000 ft. ; Khasia mountains at altitudes of 4,000 ft., and Assam.	....	Irritant hairs

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
2. *Ailanthus altissima* (Mill.) Swingle (Syn. *A. Glandulosa* Desf.) English— Ailanto, Chinese sumach, Japan varnish tree, Stinking cedar, Tree of the Gods, Tree of heaven	A large deciduous tree met with in the hills of Northern India, most probably introduced from Japan.	The flowers contain an essential oil [Isaev, 1932]. The bark contains 0·005 per cent of a very bitter crystalline substance named ailanthin and probably also a glucoside and a saponin [Wasicky and Orien, 1933].	Leaves, flowers
3. *Anacardium occidentale* Linn. English— Cashew nut, Cashew apple Vernacular— Hi. & Bo.—*Kaju ;* Be.—*Hijli badam*	A small tree originally introduced from South America; now established in the coastal districts of South India, Chittagong, and the Andaman Islands.	The cellular pericarp is full of a black, caustic, oily juice which is a powerful rubefacient and vesicant. It contains the phenolic compound cardol, anacardic acid and an ether-soluble substance to which cantharidin-like effects of the oil are attributed [Joseph and Sudborough, 1923].	Juice from the pericarp and trunk is very caustic and produces blisters. The nut within which is the kernel (the cashew nut) must be roasted to get rid off the poisonous substance. The fumes arising from their roasting are very irritating.
4. *Anagallis arvensis* Linn. English— Bird's eye, Red chickweed, Shepherd's calendar, Shepherd's delight Vernacular— Hi.—*Jonkhmari*	An erect or procumbent annual found over the greater part of India ascending to an altitude of 8,000 ft. in the Himalayas. The red-flowered variety is found in Kashmir, but the blue-flowered one is more common in India.	The herb [Wehmer, 1929-31 ; *Supplement*, 1935] contains two glucosidic saponins while the root contains cyclamin which is also a glucoside.	Leaves
5. *Anthemis cotula* Linn.	A foetid-smelling, acrid, erect annual herb found in Baluchistan and probably in Sind also.	The fresh plant yields 0·01 per cent and fresh flowers about 0·013 per cent of an essential oil [Hurd, 1885 ; Haake, 1891].	Leaves and flowers
6. *Apium graveolens* Linn. (wild form) English— Celery, Marsh parsley Vernacular— Hi. & Sans.—*Ajmoda ;* Be.—*Chanu*	A biennial herb found at the foot of the North-West Himalayas and outlying hills in the Punjab. It is cultivated in different parts of India during the cold weather, chiefly as a garden crop in the vicinity of towns for use as a salad and as a potherb. Sometimes it is cultivated in Bengal for its seed and in the Punjab for its roots.	The herb contains the glucoside apiin [Van Rijn, 1931] and an essential oil. The tubers contain very little of this oil but fruits contain 2·0 to 3 per cent.	According to Watt [1889-96] and Pammell [1911] the plant is irritant. Muenscher [1939] states that leaves are irritant.
7. *Arisaema speciosum* (Wall.) Mart. Vernacular— Pun.—*Kiralu, Samp-ki-khumb*	A herb found in the temperate Himalayas, from Hazara to Sikkim and Bhutan at altitudes of 7,000 to 10,000 ft.	....	Juice, especially from tubers

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
8. *Arisaema tortuosum* (Wall.) Schott. Vernacular— Pun.—*Don, Kiri-ki-Kukri*	A tall plant found in the temperate and subtropical Himalayas from Simla to Bhutan at altitudes of about 8,000 ft., also in Khasia Hills, Manipur, Chota Nagpur, Ranchi and Parasnath. In western India it is found in Konkan, and in the Madras Presidency in Rampa Hills at 4,500 ft., Horsleykonda at 4,000 ft., and in Western Ghats at 3,000 to 7,000 ft. above sea level. According to Duthie [1903-29] the Dehra Dun plant which is found at altitudes of 3,000 ft. differs considerably from the typical *A. tortuosum* of Schott.	....	Juice, especially from tubers
9. *Asparagus officinalis* Linn. English— Asparagus, Sparrow grass Vernacular— Hi.—*Halyun;* Be.—*Hikuna*	....	....	Young stems [Muenscher, 1939]
0. *Calotropis gigantea* (Linn.) Dryand. Vernacular— Hi.—*Ak;* Sans.—*Arka;* Be. & Bo.—*Akanda*	A stout shrub frequently met with throughout India as a weed on fallow land and in waste ground except in the Punjab where it is sometimes found in gardens only (Fl. Brit. Ind. mentions the plant as occurring in the Punjab, but this seems doubtful to us).	The fibre of this plant contains a toxic bitter substance. The juice contains a proteolytic enzyme similar to papin [Basu and Nath, 1933; 1936]. The roots contain a gutta-percha-like substance (madar alban) consisting of isovaleric esters of two alcohols, and also a bitter yellow resinous substance [Sharma, 1934; Hill and Sarkar, 1915].	Milky juice. Its action is particularly severe on mucous membrane.
1. *Calotropis procera* (Linn.) Dryand. Vernacular— Hi.—*Ak, Madar, Mundor;* Sans.—*Alarka;* Bo.—*Mandara*	A shrub found more or less throughout India in warm and dry places from the North-West Frontier Province and in the Punjab to Western, Central and Southern India, it occurs abundantly in Sub-Himalayan tracts and the adjacent plains in the North-West.	The milky juice contains a proteolytic enzyme and a toxic substance [Gerber, and Flourens, 1913]. It also contains a highly active resin [Gerber and Flourens, 1912]. The root bark contains a bitter yellow resin but no alkaloid [Sharma, 1934].	Milky juice. A child about three years old, accidentally during play, brought the juice in contact with his prepuce. He was brought to the hospital two days afterwards. The part was very much swollen and there were patches of ulceration with narcosis. The patient had difficulty in passing urine. On circumcision the glans penis was also found to be swollen and ulcerated.

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
12. *Cannabis sativa* Linn. English— Hemp. Vernacular— Hi., Be. & Bo.—*Bhang, Ganja*; Sans.—*Ganjika*	This plant is found in many parts of India on waste ground and by the roadside. In the Himalayas it grows wild and is widely distributed, while it is acclimatized in the plains and is also occasionally cultivated.	The resinous matter (charas) found on the leaves, young twigs, bark of the stem and unfertilized flowers of the female plant contains about 1·5 per cent of a terpene, about 1·75 per cent of a sesquiterpene, a hydrocarbon monakosane and a toxic red oil, which is the active constituent of the plant. The approximate yield of the red oil is 33 per cent of the resin [Wood, Spivy and Easterfield, 1896; Marshal, 1897].	Leaves, flowers
13. *Cissus setosa* Roxb. (Syn. *Vitis setosa* Wall.) English— Hairy wild vine Vernacular— Hi.—*Harmel*; Bo.—*Khajgoli-chavel*	A shrub found in Western India from the Circars and Mysore southwards	....	Juice
14. *Datura stramonium* Linn. English— Devil's apple, Jimson weed, Thorn apple Vernacular— Pun.—*Tattu dattura*; Bo.—*Sada dhutura*	A coarse, annual herb found on the Himalayas from Kashmir to Sikkim up to an altitude of 9,000 ft. It is also met with in the hilly tracts of central and southern India.	The content of the alkaloid in the leaves varies from 0·3 to 0·5 per cent, the chief alkaloid being hyoscyamine. The bark, wood and pith of the stems contain 0·25, 0·09 and 0·20 per cent of the alkaloids respectively. The roots contain 0·1 to 0·25 per cent of alkaloids and the seeds 0·46 to 0·52 per cent [Feldhaus, 1905]. In some Indian specimens the total alkaloids in stems and roots vary from 0·19 to 0·26 per cent and in leaves and fruits from 0·38 to 0·45 per cent [Andrews, 1911].	Leaves, flowers, fruits
15. *Daucus carota* Linn. English— Carrot Vernacular— Hi., Bo. & Pun.—*Gajar*; Sans.—*Shikha-mulam*	A hispid biennial herb cultivated throughout India as an article of food	The fruit of the cultivated carrot yields 1 to 1·5 per cent of an essential oil containing *l*-α- pinene, and a crystalline body named daucol [Finnemore, 1926]. The leaves contain the two bases pyrrolidine and daucine [Pictet and Court, 1907] besides an essential oil.	It has been stated that some persons develop dermatitis on coming in contact with carrot leaves, especially when they are wet.
16. *Delphinium ajacis* Linn.	Cultivated in gardens	The seeds contain 2 alkaloids crystalline ajacin and crystalline ajaconin [Wehmer, 1929-31, *Supplement* 1935].	Leaves, seeds

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
. *Dictamnus albus* Linn. English— Bastard dittany, Fraxinella, White dittany	A strong-smelling shrubby plant, met with on the temperate Western Himalayas from Kashmir to Kunawar at altitudes of 6,000-8,000 ft.; very common in Pangi.	The roots contain an ethereal oil, a bitter substance, a saponin, a crystalline dictamnolaction (probably identical with evodin), a crystalline toxic alkaloid dictamnin and also a phenolic substance. The flowers contain 0·05 per cent and leaves 0·15 per cent of an essential oil [Wehmer, 1929-31, *Supplement* 1935].	Leaves, capsules
. *Erigeron canadensis* Linn. English— Cobbler's pegs, Canada fleabane Vernacular— Kash.—*Ka·h*	An annual herb found in the Western Himalayas, Punjab and Rohilkhund up to an altitude of 4,000 ft. It is plentiful in certain valleys in Kashmir. It is also found in Shillong (Assam) and on the Western Ghats and Nilgiris up to 6,000 ft. above sea level.	Fresh leaves contain 0·33 to 0·66 per cent and dry leaves 0·26 per cent of an essential oil [Wehmer, 1929-31, *Supplement* 1935; Rabak, 1905]. Tannic acid and gallic acid have also been isolated from the leaf [Wehmer, 1929-31, *Supplement* 1935].	Leaves. The oil has an acrid taste and causes smarting of the eyes and soreness of the throat. The leaves produce irritation of the parts of the body coming in contact with the plant,. When powdered the leaves produce a dust which is irritating [Pammell, 1911].
. *Euphorbia acaulis* Roxb. (Syn. *E. fusiformis* Buch.-Ham.)	Found in the tropical Himalayas, Oudh, Bengal and western India	....	Milky juice very acrid and vesicant
. *Euphorbia antiquorum* Linn. Vernacular— Hi.—*Tridhara-sehund*; Sans.—*Vajrakantaka*; Be.—*Tekata sij*; Bo.—*Narasej*	A large shrub or a small tree found in dry places throughout the hotter parts of India ascending to an altitude of 2,000 ft. It is also occasionally cultivated as hedge plant in villages.	....	Milky juice intensely irritant. During the collection of juice by the authors, the person employed for the purpose complained bitterly of itching all over the face, which was also considerably swollen. The trouble, however, was relieved by the application of a soothing preparation for a couple of days.
1. *Euphorbia cattimando* W. Elliot (*E. trigona* Fl. Brit. Ind., in part)	An erect shrub found on the dry rocky hills in the Deccan, and probably other parts of India	Contains euphorbon [Henke, 1886].	Milky juice, which is vesicant in fresh condition
2. *Euphorbia helioscopia* Linn. English— Cat's milk, Sun spurge, Wartwort Vernacular— Hi.—*Hirruseeah*; Pun. *Ganda bute*	An annual herb which is a common field weed in spring throughout the plains of the Punjab and the Siwalik tract, ascending to 8,000 ft. in the outer Himalayas. It is also found wild in the Nilgiris where it has been introduced.	The fresh herb contains a non-haemolytic saponin and also an acid saponin which is strongly haemolytic [Gonnerman, 1919]. The seeds contain 32·6 per cent of a fatty oil the physiological action of which is due to a powerful purgative principle [Gillot, 1926].	Milky juice. Dymock [1884] reports a case of severe ulceration resulting from the application of a poultice made from the bruised plant.

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
23. *Euphorbia neriifolia* Linn. Vernacular— Hi.—*Sehund*; Sans.—*Snuhi*; Be.—*Massasj*; Bo.—*Minguta*	A large fleshy shrub occasionally planted in villages as a hedge plant throughout India and is sometimes found wild on waste land. In Orissa and in the Deccan it is said to occur in a state of nature in rocky places.	....	Milky juice is rubefacient and acrid
24. *Euphorbia nivulea* Buch.-Ham. Vernacular— Be.—*Sij*; Bo.—*Newrang* Sans.—*Patta kuie*	A large shrub or a small tree found in dry rocky places in Northern, Central and Southern India	....	Milky juice
25. *Euphorbia peplus* Linn.	Probably an introduced species	The herb contains 4·8 per cent of an oleo-resin [Vevey, 1908]. It also contains neutral and acid saponins with haemolytic properties [Gonnerman, 1919].	Milky juice
26. *Euphorbia rothiana* Spreng.	Found in Central, Western and Southern India	....	Milky juice
27. *Euphorbia royleana* Boiss. Vernacular— Hi. & Pub.—*Shakar pitam, Thor*	A fleshy shrub common on the dry and hot rocky slopes of the outer ranges of the Western Himalayas from the Indus to Kumaon, ascending to an altitude of 6,000 ft.; also on the Salt Range in the Punjab. It is also commonly grown in hedges in the Sub-Himalayan tract and the adjacent plains.	....	Milky juice. Very injurious to the eyes.
28. *Euphorbia thomsoniana* Boiss. Vernacular— Kash.—*Hirtiz*	It occurs in Western Tibet, Kurrum, Kashmir (Gilgit), etc. at altitudes of 10,000 to 12,000 ft.	....	Milky juice
29. *Euphorbia tirucalli* Linn. English—Milk bush, Indian tree spurge Vernacular—Hi.—*Sehund*; Be.—*Lanka sij*; Bo.—*Shera*	An unarmed shrub or a small tree which is a native of Africa and has become naturalized in several places in India. It is often grown as a hedge or occasionally as a road-side tree.	The milky juice contains about 20 per cent of resins [Wehmer, 1929-31, *Supplement* 1935].	Milky juice is rubefacient and vesicant. It produces severe inflammation and excruciating pain if it gets into a cut in the skin or into the eyes. It is said to be used by criminals to destroy the eyes of domestic animals.
30. *Euphorbia trigona* Haw. (*E. trigona* Fl. Brit. Ind., in part) Vernacular—Tel.—*Kattimandu*	An erect, glabrous shrub, found in the dry rocky hills in the Deccan.	The milky juice contains euphorbon, resin, rubber-like substances and malic acid [Wehmer, 1929-31, *Supplement* 1935].	Milky juice is acrid and in fresh condition is vesicant.

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
31. *Excoecaria agallocha* Linn. English—Blinding tree Vernacular—Be.—*Gangwa* ; Bo.—*Geva*	A small tree found in tidal forests and swamps on all the coasts of India.	....	The fresh sap is extremely acrid and causes intolerable pain if it accidentally gets into the eyes, which sometimes happens to wood cutters when the tree is cut for fuel ; hence the name ' Excoecaria '. It blisters the skin and produces sores.
32. *Fagopyrum esculentum* Moench. English—Buckwheat, Brank Vernacular—Hi.—*Ko u, Kaltu, Phaphra* ; Pun.—*Darau, Phaphar, Obal* ; Kash.—*Trumba shirin.*	An annual herb extensively cultivated in the Himalayas and Sub-Himalayan tracts and in Western Tibet at altitudes of 2,000 to 12,000 ft. ; also in the Khasia Hills, Manipur, as well as in the hilly districts of Central and Southern India.	The herb contains the glucoside rutin, the seeds contain a substance which is toxic to lower animals [Ohmke, 1909]. The roots are said to contain oxymethylanthraquinones [Maurin 1925 ; 1926].	All parts of the plant, whether dry or fresh, are capable of producing photosensitization (fagopyrism) in animals, the fresh plant in the flowering stage being considered most toxic. The symptoms are : inflammatory swelling accompanied by severe itching of the ears, face and eyelids, spreading on to the sub-maxillary region and neck. In severe cases vesicles containing yellowish fluid appear on the affected part. These vesicles may become infected with bacteria and give rise to purulent and even narcotic dermatitis. Among human beings certain individuals are known to be sensitive to buckwheat. They experience severe itching and develop a rash from eating food made from buckwheat flour.
33. *Fleurya interrupta* Gaudich. Vernacular—Hi.—*Lal bichua*	An erect herb found in Bihar, Central Bengal and Khasia Hills. In the Bombay Presidency it is met with in Konkan, Southern Mahratta Country and Kanara. In the Presidency of Madras it has been reported from the hills south of Mysore at altitudes of 5 000 to 6,000 ft. above sea level and also from the Rampa hills of the Eastern Ghats.	....	Stinging hairs on plant
34. *Ginkgo biloba* Linn. English— Maiden-hair tree	Rarely cultivated in gardens. There is one tree in Amritsar.	The leaves contain five crystalline substances and also shikiminic acid. The seeds contain gingkol acid, two alcohols, ginnol and bilobol, and also asparagin [Wehmer, 1929-31, *Supplement* 1935].	Seeds

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
35. *Girardinia heterophylla* Decne. The varieties *zeylanica* and *palmata* of the Flora of British India are now considered by several botanists as distinct species, viz. *G. zeylanica* Decne. and *G. leschenaultiana* Decne. respectively. *G. zeylanica* is found in the south-western hilly portion of the United Provinces and extends through Chota Nagpur, Mt. Abu, Konkan and the Deccan to the hills of Southern India and the west coast of Madras Presidency from 1,000 to 5,000 ft. above sea level. *G. leschenaultiana* is more restricted in its distribution and is found on the mountains of the Western Ghats at altitudes of 4,000 to 7,000 ft. Both these are known as Nilgiri nettles while the name Himalayan nettle is restricted to *G. heterophylla*. English— Himalayan nettle Vernacular— Hi.—*Alla, Bichua, Chichr* ; Pun.—*Anjan, Bhabar, Karla*	A perennial herb found in the subtropical and temperate Himalayas from Kashmir to Sikkim, up to 7,000 ft. above sea level, also in Assam and the Khasia Hills.	....	Stinging hairs on the plants
36. *Hedera helix* Linn. English— Barren ivy, Creeping ivy, Ivy Vernacular— Hi.—*Lablab* ; Pun.—*Banda* ; Kash.—*Karmora*	An evergreen, climbing shrub found in the Himalayas from 6,000 to 10,000 ft. above sea level and in the Khasia Hills from 4,000 to 6,000 ft.	Nearly all parts of the plant, viz. leaves, fruits and seeds contain the glucoside α-hederin and probably certain other glucosides [Van der Haar, 1912 ; 1913; Block, 1888].	Leaves
37. *Hippomane mancinella* Linn. English— Manchineal tree	A much branched tree introduced from America, it is now occasionally cultivated in Indian gardens.	It contains acrid milky juice [Wehmer 1929-31, *Supplement* 1935].	Milky juice
38. *Holigarna arnottiana* Hook *f.* Vernacular— Bo.—*Bibu*	A tall tree found in the evergreen forests on the Western Ghats from the Konkan southwards.	....	Juice. In some persons it produces blisters, while others are immune. The tree is dreaded by the local people.
39. *H. grahamii* (Wight) Hook. *f.* Vernacular— Mar.—*Bilwuli, Bipte*	A tree found in Western India	....	The juice has properties similar to those of *H arnottiana.*
40. *H. longifolia* Buch.-Ham. *ex* Roxb. Vernacular— Be.—*Barola*, Bo.—*Huluguri*	A tall tree native of Eastern Bengal and Chittagong.	....	The juice is of a powerfully caustic nature and blisters the skin.

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
41. *Humulus lupulus* Linn. English— Hops.	It is cultivated in the North-West Himalayas	The active principles constitute the lupulin	Leaves
42. *Hypericum perforatum* Linn. English— St. John's grass, St. John's wort Vernacular— Hi. and Pun.—*B s-sant*	A perennial herb found in the Western temperate Himalayas from Kumaon between 6,000 to 9,000 ft. to Kashmir between 3,000 to 6,500 ft. above sea level.	The herb contains tannins and 0.065 per cent of an essential oil [Zellner and Porodko, 1925].	Several investigators have reported that the plant in the flowering stage, if eaten in large amounts by livestock, leads to a photosensitization and consequent dermatitis of the unpigmented portions of the skin. Animals having pigmented skins or those not exposed to bright sunlight do not develop any symptoms, but white-skinned horses, cattle and sheep develop characteristic symptoms (see under *Fagopyrum esculentum*) if exposed to sunlight. The toxic substance, it appears, acts upon the nerve-endings so as to photosensitize them and if the animal is subsequently exposed to strong sunlight, it develops dermatitis, including blistering of the skin and falling off of the hair.
43. *Laportea crenulata* Gaudich. English— Devil nettle, Elephant nettle, Fever nettle Vernacular— Hi.—*Utijun* ; Be.—*Chorpatta*	A stinging shrub or a small tree found in the tropical Himalayas from Sikkim eastward, also in Assam and the Khasia Hills. In the Madras Presidency it is found in the Western Ghats at altitudes of 1,000 to 5,000 ft. and in Rampa Hills at 2,500 ft. above sea level.	According to Smith [1923] the toxic principle is formic acid but the authors have not been able to confirm this by reference to original papers consulted by them.	Stinging hairs on plant. It is perhaps the worst of all the stinging nettles found in India. A contact with the hairs produces severe burning pain which may last for several days and is said to be greatly aggravated by the application of water. The sting is particularly powerful during the flowering season when it is said to bring on voilent sneezing, sleeplessness and fever, hence the local English names (Fever nettle, Devil nettle) by which the plant is known to coffee planter and other English residents. Haines [1921-25] remarks that while cutting coupe lines in November in the Sikkim Terai, where it is sometimes gregarious, his coolies were attacked with sneezing, violent catarrh and ultimately vertigo, apparently from inhaling numerous minute hairs.

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
44. *Laportea terminalis* Wight	An erect herb found in the subtropical Himalayas from Kumaon to Mishmi at altitudes of 4,000 to 8,000 ft., in the Central Provinces at altitudes of 4,000 to 6,000 ft., and in the evergreen forests of the Western Ghats of the Madras Presidency at altitudes of 5,000 to 7,000 ft. It is also found in the Nilgiris.	....	Stinging hairs on plant
45. *Lasiosiphon eriocephalus* Decne. English— Woolly-headed gnidia Vernacular— Bo.—*Rametha*	A shrub, sometimes a small tree, found in the open forests of the Western Ghats of the Bombay and Madras Presidencies ascending to an altitude of 7,000 ft. in the Nilgiris.	....	The bark (and perhaps the leaves also) is powerfully vesicant. The collector of the bark for examination by the authors complained bitterly of a burning sensation in the eyes, nostrils and face during packing of the dried bark in bags. This sensation lasted, more or less, for three days.
46. *Leonurus cardiaca* Linn.	A herb found in temperate Western Himalayas from Kashmir to Kumaon at altitudes of 6,000 to 10,000 ft.	The herb contains an amorphous bitter substance leonurin [Wehmer, 1929-31, *Supplement* 1935].	Leaves
47. *Lobelia excelsa* Lesch.	A herb which grows on the Western Ghats of South India, the Nilgiris, Pulney Hills and hills of Travancore at altitudes of over 5,000 ft.	....	Milky juice
48. *Lobelia nicotianifolia* Heyne English— Wild tobacco Vernacular— Hi.—*Nala, Narasala ;* Be.—*Balanala, Nala ;* Bo.—*Bokenal, Dhivala*	A herb found on the Western Ghats from Bombay to Travancore at altitudes of 3,000 to 7,000 ft. above sea level and is met with in Konkan, the Deccan, the Nilgiris, Malabar, etc.	The leaves contain two alkaloids one of which resembles lobeline from *L. inflata* Linn. [Dragendorff and Rosen, 1886].	Milky juice. The dust from the powdered herb irritates the nostrils in the same way as tobacco.
49. *Mucuna atropurpurea* DC.	A woody climber found in the plains of Western India	....	See *Mucuna prurita*
50. *Mucuna gigantea* DC. English— Elephant cowitch Vernacular— Mal.—*Kakavalli ;* Tam.—*Kalgaivalli ;* Tel.—*Enugadulagondi*	A woody climber found in the plains of Western India	....	See *Mucuna prurita*

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
51. *Mucuna hirsuta* Wight & Arn.	An annual climber found in the plains of Western India	....	See *Mucuna prurita*
52. *Mucuna monosperma* DC. English— Negro bean Vernacular— Bo.—*Sonogravi, Mothi-kuhili*	A woody climber of the Eastern Himalayas and Khasia Hills, also met with in Assam, Chittagong, and the hills of Western India.	....	See *Mucuna prurita*
53. *Mucuna prurita* Hook. (*M. pruriens* Fl. Brit. Ind., *non* DC.) English— Cowhage, Cowitch Vernacular— Hi.—*Kiwach ;* Sans.—*Atmagupta ;* Be.—*Alkushi ;* Bo.—*Kuhili*	An annual climber found in the Himalayas and the plains.	....	The rigid, pointed hairs on the pods, if touched enters the skin and produce itching. The action appears to be purely mechanical.
54. *Nerium oleander* Linn.	Rarely cultivated in gardens ; a plant of the Mediterranean region.	The leaves contain the glucosides neriin and oleandrin	Leaves
55. *Podophyllum hexandrum* Royal (Syn. *P. emodi* Wall. *ex* Hook *f.* & Thoms.) English— Ducks foot, May apple Vernacular— Hi.—*Papra ;* Kash.—*Banwangan ;* Pun.—*Bankakri*	A herb found in the interior ranges of the Himalayas at altitudes of 9,000 to 14,000 ft. from Sikkim to Hazara descending to 6,000 ft. in Kashmir.	The rootstock yields resin (podophyllin) and crystallised podophyllotoxin 10 per cent and 3.5 per cent respectively.	Rootstocks. Podophyllin greatly irritates the eyes and the mucous membranes generally. The collectors of this drug have to be very careful.
56. *Polygonum hydropiper* Linn. English— Biting pepper, Smartweed Vernacular— Be.—*Packur-mul*	A herb found in wet places more or less throughout India, ascending to an altitude of 7,000 ft. in the Himalayas.	The herb contains formic acid, acetic acid and baldrianic acid, much tannin and small amounts of an essential oil [Steenhauer, 1919]. The root is said to contain oxymethyl-anthraquinones [Maurin, 1925 ; 1926].	The fresh plant contains an acrid juice which causes irritation and smarting when brought into contact with the nostrils or eyes. The bruised leaves as well as the seeds will raise blisters if employed as a poultice, as in the case of mustard poultice.
57. *Ranunculus sceleratus* Linn. English— Marsh crowfoot, Water celery Vernacular— Kum.—*Shim ;* Pers.—*Kabkaj*	An erect, annual herb met with on river banks in Bengal and Northern India, in the marshes of Peshawar and in the warm valleys of the Himalayas. It appears during the cold weather and remains until the break of the rains.	The plant contains anemonin, anemon acid and an essential oil [Wehmer, 1929-31, *Supplement* 1935].	Leaves. The fresh plant is highly acrid. The bruised leaves when applied to the skin raise blisters and were formerly used in Europe by professional beggars to produce or maintain blisters or open sores to excite sympathy.
58. *Rhus insignis* Hook *f.* Vernacular— Lep.—*Serh ;* Nep.—*Kagphulai*	A small tree found in the interior valleys of the Sikkim Himalayas at altitudes of 3,000 to 6,000 ft., and in the Khasia Hills at 4,000 ft.	....	Leaves, bark, fruit. The juice is a powerful vesicant.

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
59. *Rhus punjabensis* J. L. Stew. *ex.* Brand. Vernacular— Pun.—*Arkhar, Kakk ein, Titari*	A small or medium-sized tree found in the North-Western Himalayas at altitudes of 2,500 to 8,000 ft. from the Indus eastwards and is common in the inner ranges in moist ravines, etc.	....	Leaves, bark, fruit. The juice is a vesicant.
60. *Rhus succedanea* Linn. English— Crab's claw, Japan wax tree, Red lac sumach Vernacular— Hi. and Be.—*Kakra-singi;* Bo.—*Takada-singi* ; Pun.—*Arkhol*	A medium-sized tree found in the temperate Himalayas from Kashmir to Sikkim and Bhutan at altitudes of 3,000 to 8,000 ft. It also occurs in the Khasia mountains between 2,000 and 6,000 ft., and in Sind.	The leaves contain about 20 per cent of tannin. The milky juice yields a lac similar to Japan lac with laccol, a toxic phenol. Laccol is identical with urshiol [Wehmer, 1929-31 *Supplement* 1935].	Leaves, bark, fruit. The juice is a vesicant.
61. *Rhus wallichii* Hook. *f.* Vernacular— Hi.—*Akoria ;* Nep.—*Chosi ;* Pun.—*Arkhar, Arkol*	A small tree found in the temperate Himalayas from Garhwal to Nepal, occurring at altitudes of 6,000 to 7,000 ft. above sea level.	....	Leaves, bark, fruit. The juice possesses vesicant properties.
62. *Rumex acetosa* Linn. English— Dock sorrel, Sorrel	A perennial herb met with in the Western Himalayas from Kashmir to Kumaon, at altitudes of 8,000 to 12,000 ft.	The plant contains oxalates as well as free oxalic acid [Berthelot and Andre, 1886; Fleury, 1889]. It contains acid potassium oxalate and some tartaric acid [Watt and Brayer-Brandwijk, 1932]. Purdie [1927] found 1.36 per cent of potassium binoxalate in the juice. Maurin [1926] reports 1.05 per cent of oxymethyl-anthraquinone from the roots and traces of the same from the leaves.	Leaves produce dermatitis in susceptible persons.
63. *Rumex acetosella* Linn. English— Field sorrel, Sheep's sorrel, Sourack Vernacular— Be.—*Chukapalam ;* Sans.—*Chutrika*	A perennial herb found in the Eastern Himalayas in Sikkim at altitudes of 7,000 to 8,000 ft.	The herb contains oxalates as well as free oxalic acid. Also contains potassium binoxalates [Orlandini, 1933].	Leaves
64. *Ruta graveolens* Linn., var. *angustifolia* Hook *f.* English— Common rue, Countryman's treacle, Garden rue Vernacular— Hi.—*Pismarum, Sadab ;* Be.—*Ermul, Ispund ;* Bo.—*Satap*	Occasionally cultivated in gardens	An essential oil	Leaves. If much handled they produce redness, swellings and even vesication of the part with which they come in contact.

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
65. *Sapium insigne* Trimen. Vernacular— Hi.—*Khinna*; Bo.—*Dudla*; Pun.—*Bilcja, Dudla*	A small or middle-sized tree found in the Sub-Himalayan tract and outer Himalayas from the Ravi eastwards to Bhutan (not in Sikkim) ascending to an altitude of 5,500 ft.; also in Assam, Chittagong and Orissa. In Western and Southern India it is common near the seacoast of Konkan and North Kanara, and is also found in the Deccan, hills of Kurnool, Cuddapah and Nellore, Kambakam Hill in Chingleput, Western Ghats and West coast, and is usually found in rocky places up to 6,000 ft. above sea level.	....	Milky juice is acrid and acts as a vesicant.
66. *Schima wallichii* Choisy. Vernacular— Hi.—*Chilauni, Makusal*	A large evergreen tree of the Eastern Himalayas, from Nepal and Sikkim to Bhutan, found at altitudes between 2,000 and 5,000 ft. It also occurs in Assam, the Khasia hills and Chittagong.	Leaves contain saponin [Wehmer, 1929-31, *Supplement* 1935].	The bark, in which the liber cells appear like glistening-white needles, irritates the skin in the same way as cowhage (*Mucuna prurita*).
67. *Semecarpus anacardium* Linn. *f.* English— Common marking nut tree Vernacular— Hi. and Be.—*Bhela*; Bo.—*Biba*; Sans.—*Bhallātamu*	A moderate-sized tree found in the Sub-Himalayan tract from the Beas eastwards, ascending in the outer hills up to 3,500 ft., Assam, Khasia Hills, Chittagong, Central India, Gujerat, Konkan, Southern Mahratta Country, Kanara and in deciduous forests of all districts in the Madras Presidency.	Earlier investigators suggested that the black corrosive juice of the pericarp contained a tarry oil consisting of 90 per cent of an oxy-acid named anacardic acid and 10 per cent of a higher non-volatile alcohol called cardol. Naidu [1925] isolated catechol and a monohydroxy phenol which he called 'anacardol' besides two phenolic acids and a fixed oil from the kernel of the nut. Pillay and Siddiqui [1931] were unable to find either anacardic acid or cardol or catechol and anacardol as reported by previous investigators. They isolated the following constituents from the juice of the pericarp: (*a*) A monohydroxyphenol which forms 0.1 per cent of the extract, (*b*) Ano-dihydroxy compound forming about 46 per cent of the extract; and (*c*) A tarry, non-volatile corrosive residue forming 18 per cent of the nut.	Juice from pericarp and the tree-trunk. It is a powerful counter-irritant and vesicant and has been used by malingerers for producing ophthalmia and skin lesions, as also by others for imitating bruises in support of a false charge. Cases are known where the juice has been employed to cause injury to other persons.

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
68. *Semecarpus travancoricus* Bedd. Vernacular— Mal. — *Avukaram;* Tam.—*Shenkottal;* Tel.—*Natu sengota*	A very large tree found in the evergreen forests of Tinnevelly and Travancore up to an altitude of 4,000 ft.	....	Juice; properties similar to that of *S. anacardium*
69. *Tragia bicolor* Miq.	A slender climbing herb found in the Western Ghats, the Nilgiris and Pulney Hills at an altitude of 5,000 to 6,000 ft. in Shola forests.	....	Stinging hairs on plant
70. *Tragia involucrata* Linn. (with varieties in the Flora of Brit. Ind. which are now treated as distinct species, viz. *T. hispida* Willd., *T. muelleriana* Pax and Hoffm., *T. cannabina* Linn. *f.* and *T. montana* (Thw.) Muell-Arg. Vernacular— Hi.—*Barkanta;* Be.—*Bichuti;* Bo.—*Kanchkuri;* Sans.—*Vrishchikali*	A perennial twining herb found throughout India from the Punjab and the outer Himalayan ranges esatward to Assam, and southward to Travancore.	....	Stinging hairs on plant
71. *Urtica dioica* Linn. English— Common nettle, Stinging nettle Vernacular— Hi. and Pun.—*Bichu, Bichua*	An erect herb found in the North-West Himalayas from Kashmir and the Salt Range to Simla at altitudes of 8,000 to 10,700 ft. and in Western Tibet at altitudes of 8,000 to 12,000 ft.	The plant contains lecithin and a glucoside [Wehmer, 1929-31, *Supplement* 1935]. According to Cleery [1927] the protoplasm of hairs has an alkaline reaction, and encloses an acid cell sap. The cell sap contains a small amount of formic acid as well as acetic, butyric and other volatile fatty acids. The specific poison of the cells, which is a non-volatile substance of an acid nature allied to the resin acids, is in solution in these acids.	Stinging hairs on plant
72. *Urtica hyperborea* Jacq. Vernacular— Ladd.—*Dzatsutt, Stokpotsadma, Zatud*	A low, densely tufted undershrub found in Western Tibet at altitudes of 12,000 to 17,500 ft. and in Eastern Tibet between altitudes of 16,000 to 17,000 ft.	....	Stinging hairs on plant
73. *Urtica parviflora* Roxb. Vernacular— Kum.—*Berain, Bichhu, Shishona*	A slender herb found in the temperate Himalayas from Kashmir to Mishmi between altitudes of 5,000 to 12,000 ft. The flora of British India also records it from Ootacamund in the Nilgiris.	....	Stinging hairs on plant
74. *Urtica pilulifera* Linn. English— Roman nettle	A common European stinging weed occurring occasionally near Simla and elsewhere near habitations in the hills.	The seeds contain a fatty oil and a glucoside [Wehmer 1929-31, *Supplement* 1935].	Stinging hairs on plant

Name of plant	Distribution	Constituents	The part or parts of the plant which cause dermatitis
75. *Wallichia disticha* T. Anders. Vernacular— Lep.—*Katong*	A handsome palm of the outer hills of Sikkim	....	Berries and perhaps also the leaves [Watt, 1889-96]
76. *Xanthium strumarium* Linn. English— Bur-weed, Cocklebur Vernacular— Hi.—*Chhota-gokru* ; Be.—*Bon-okra* ; Bo.—*Shankeshvara* ; Sans.—*Arishta*	A herb throughout the hotter parts of India, usually near habitations, ascending in the Western Himalayas to an altitude of 6,000 ft.	1·27 per cent of amorphous glucoside xanthostrumarin, etc. in seeds [Zander, 1881].	Leaves cause severe vesicular dermatitis in susceptible persons. Our plant collector is particularly sensitive to it. It is only, however, in the growing season that he suffers. In November when the plant is withering he is not susceptible.

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In the case of botanical and zoological names the International Rules of Botanical Nomenclature and the International Rules of Zoological Nomenclature should be followed.

References to literature, arranged alphabetically according to author's names, should be placed at the end of the article, the various references to each author being arranged chronologically. Each reference should contain the name of the author (with initials), the year of publication, title of the article, the abbreviated title of the publication, volume and page. In the text, the reference should be indicated by the author's name, followed by the year of publication enclosed in brackets; when the author's name occurs in the text, the year of publication only need be given in brackets. If reference is made to several articles published by one author in a single year, these should be numbered in sequence and the number quoted after year both in the text and in the collected references.

If a paper has not been seen in original it is safe to state 'Original not seen'.

Sources of information should be specifically acknowledged.

As the format of the journals has been standardized, the size adopted being crown quarto (about $7\frac{1}{8}$ in. $\times 9\frac{5}{8}$ in. cut), no text-figure, when printed, should exceed $4\frac{1}{2}$ in. $\times$ 5 in. Figures for plates should be so planned as to fill a crown quarto plate, the maximum space available for figures being $5\frac{3}{4}$ n. $\times 8$ in. exclusive of that for letter press printing.

Copies of detailed instructions can be had from the Secretary, Imperial Council of Agricultural Research, New Delhi.